The 8th East Asia Accelerator Mass Spectrometry Symposium (EA-AMS 8)

Sakata Hirata Hall, Nagoya University
Nagoya, Japan
December 3-6, 2019

ISEE
Institute for Space-Earth Environmental Research
JAEA

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TOKYO, JAPAN

Contents

Presentation Schedule

Abstracts

Welcome from the EA-AMS 8 Organizing Committee

It is our pleasure to welcome you to the 8th East Asia Accelerator Mass Spectrometry Symposium (EA-AMS 8) held in Nagoya, Japan.

The EA-AMS symposium started at Tsukuba University, Japan in 2006, by Japanese, Korean and Chinese AMS groups to encourage and promote AMS studies in East Asian countries. Since then, this symposium has held continuously almost every two years, and the latest symposium was held in Guilin, China, with almost 100 participants from ten countries. Following success of EA-AMS 7, we gathered together in Nagoya.

We organize nine oral sessions (40 presentations) and two poster sessions (42 presentations) in this symposium on the topics of new AMS facilities, advances in AMS techniques as well as studies on cosmogenic isotope analysis, and applications of AMS on various fields. Active discussion is very welcome and we hope the EA-AMS 8 will be a kick off of new expansion for all participants.

In the Mid-conference One-day Trip, we plan to visit the Tono Geoscience Center (TONO), Japan Atomic Energy Agency (JAEA) and Toyota Kaikan Museum. At the TONO, you can see 5 MV tandem Pelletron type accelerator installed by NEC and a new compact AMS system. You can experience the automobile production processes at the Toyota Kaikan Museum. After the One-day Trip, you will enjoy the Gala Dinner at a traditional Japanese restaurant.

We wish all participants to keep academic interests and enjoyable experiences in Nagoya.

Committees

Scientific Committee

BURR, George
FINK, David
HE, Ming
HONG, Wan
HUA, Quan
IMAMURA, Mineo
JIANG, Shan
JULL, A.J. Timothy
KIM, Joon-Kon
LI, Hong-Chun
MATSUZAKI, Hiroyuki
PARK, Junghun
SASA, Kamikazu
SHEN, Hongtao
XU, Xiaomei
ZHOU, Weijian

Organizing Committee

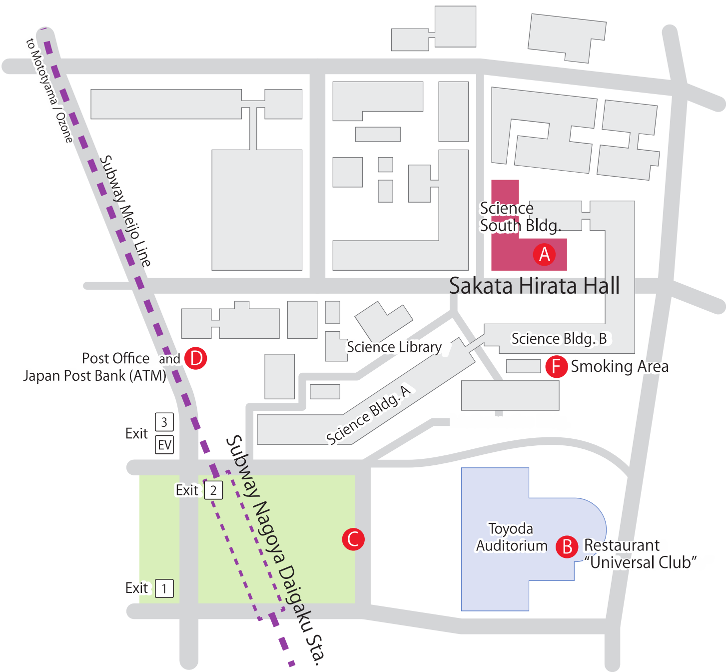
ISEE, Nagoya University

NAKAMURA, Toshio (Chair)
KITAGAWA, Hiroyuki
MINAMI, Masayo
MIYAKE, Fusa
YAMANE, Masako

Tono Geoscience Center, JAEA

KOKUBU, Yoko
FUJITA, Natsuko
WATANABE, Takahiro

Map of Higashiyama Campus, Nagoya University (East Side)



A. Conference Venue
B. Lunch Venue
C. Buses for One-day Trips
D. Post Office / Japan Post Bank (ATM)
F. Smoking Area

Smoking is prohibited in the Nagoya University Campus except for some smoking areas.

General Information

Conference Venue

All the sessions and ice breaker are held at Sakata Hirata Hall on the ground floor of the Science South Building (A in the campus map) in Higashiyama campus, Nagoya University.

Conference Badge

Conference registration badge must be attached to attend all sessions, ice breaker, coffee breaks, lunches, and social events during the conference.

Coffee breaks & Lunches

Daily coffee breaks and lunches are provided as a part of the conference participation fee. Coffee and snacks are served during the morning and afternoon coffee breaks at the entrance area of Sakata Hirata Hall in the Science South Building (A in the campus map). Lunch is served in Restaurant "Universal Club" (B in the campus map). In order to receive lunch vouchers, you must show your conference badge.

Social Program

- Pre-Conference Ice Breaker (December 2 (Mon), 16:00-18:00)

We welcome you to the Pre-Conference Ice Breaker, held at the Sakata-Hirata Hall (A in the campus map). The reception will include light snacks and drinks. Please enjoy it. A registration booth will be open at the Ice Breaker.

- Mid-Conference One-day Trip (December 5 (Thu), 8:30-17:30)

We visit Geoscience Center(TONO) , Japan Atomic Energy Agency and Toyota Kaikan Museum. At the TONO, you can see 5 MV tandem Pelletron type accelerator (NEC, US) and at the Toyota Kaikan Museum, you can see the automobile production processes. Registrants should gather at the point C in the campus map at 8:20 AM Thursday morning. Buses will depart Nagoya University at 8:30 AM.

- Gala Dinner (December 5 (Thu), 18:00-20:00)

After the Md-Conference One-day Trip, the buses directly go to the restaurant, "THE KAWABUN NAGOYA." Those who do not attend the Trip should gather directly at the restaurant until 18:00. The Gala Dinner will be held at the restaurant. A selection of delicious Japanese cuisine course will be served.

THE KAWABUN NAGOYA website:
https://www.thekawabunnagoya.com/thekawabunnagoya/

- Post-Conference One-day Field Trip (December 7 (Sat), 8:30-18:30)

We visit Fukui prefectural Varve Museum for seeing Lake Suigetsu varves, and Wakasa Mikata Jomon Museum for seeing artefacts from Jomon Period. This is a special event and is not included in the full package.

Access to Nagoya University, Higashiyama Campus

From Centrair (Central Japan International Airport):

Get on the *Meitetsu Train* and get off at Kanayama Station. It takes about 30 min by Rapid Limited Express, and costs 830 JPY. There are a variety of destinations, but every train stops at Kanayama Station. We advise you to get on “Rapid Limited Express (fastest)” or “Limited Express (second fastest)”. Kanayama Station is the second stop for Rapid Limited Express, and the seventh stop for Limited Express. The both types are operated every 30 min in the daytime. (Operating hours, approx. 5:30–23:00.) The ticket for a reserved seat (called “μ-ticket”) costs additional 360 JPY, which you can pay on the train.

At Kanayama Station, walk to the Subway Kanayama Station (subway station number M01/E01) and take the Subway Meijo Line (counter clockwise) to Nagoya Daigaku Station (M18). It takes 20 min, and costs 270 JPY. In the daytime, subways operate every 10 min for the Meijo Line. The shuttle bus from Airport to Nagoya downtown (Sakae area) is also available (60 min).

From Nagoya Station (subway station number H08/S02/AN01):

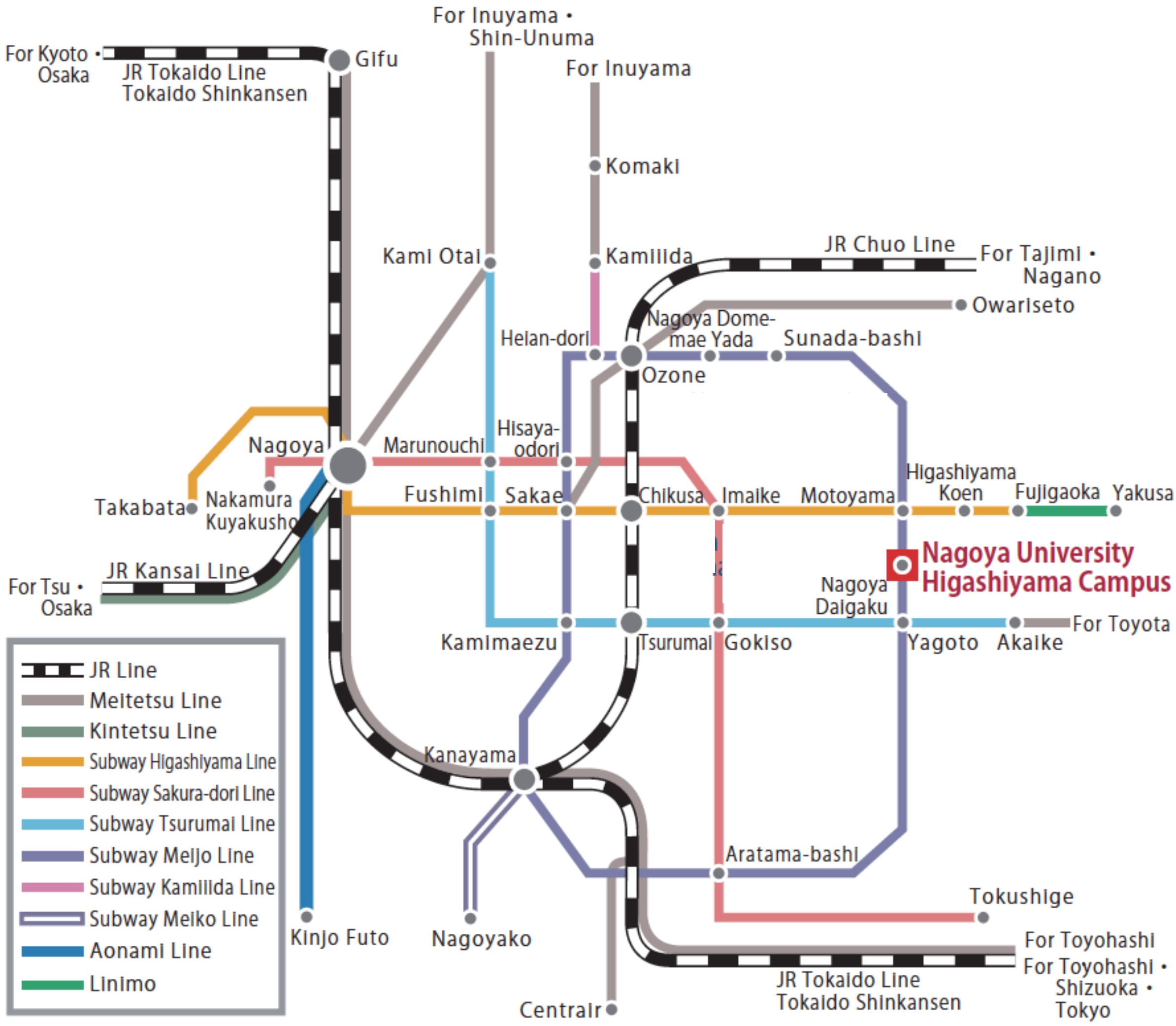
Get on the Subway Higashiyama Line to Motoyama Station (station number H16/M17) for 15 min, and then transfer to the Subway Meijo Line to Nagoya Daigaku Station (M18) for 3 min. It takes about 35 min including wasted time for transfer, and costs 270 JPY. In the daytime, subways operate every 5 min for the Higashiyama Line, and every 10 min for the Meijo Line.

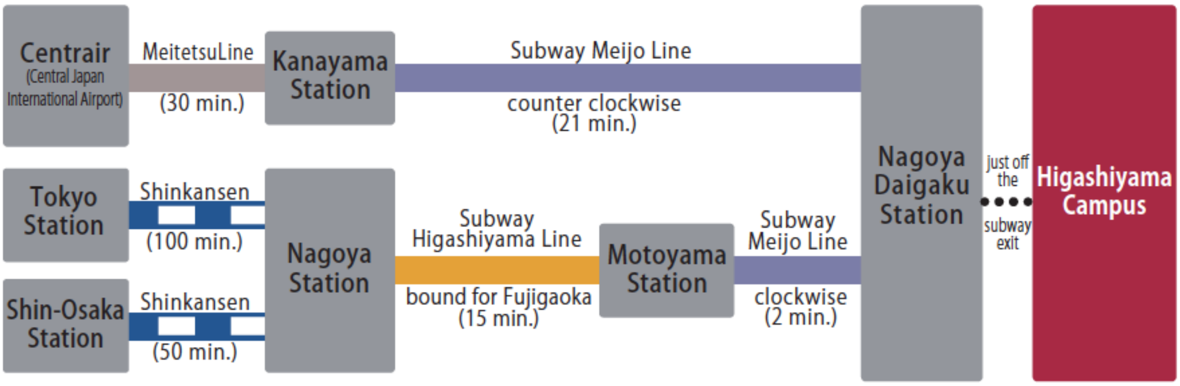
If you use a taxi to Nagoya University directly, it takes about 30 min and costs about 2,500 JPY. Please specify the destination as “Subway Nagoya Daigaku Station”.

From Sakae Station (subway station number H10/M05)

Get on the Subway Higashiyama Line to Motoyama Station (H16/M17). Then, transfer to the Subway Meijo Line (clockwise) and get off Nagoya Daigaku Station (M18). It takes about 30 min including wasted time for transfer, and costs 240 JPY.

Traffic Guide Map





Schedule Overview

Time	Dec. 2 Mon	Dec. 3 Tue	Dec. 4 Wed	Dec. 5 Thu	Dec. 6 Fri
8:20				Mid-Conference One-day Trip	
8:40		Registration			
9:00			New facility and status report I		General AMS application / Carbon-14 age calibration and archaeological application
9:20					
9:40		Pre-session			
10:00					
10:20			Coffee and tea		Coffee and tea
10:40			New facility and status report II		Space and earth environmental science III
11:00					
11:20					
11:40		Lunch			Business meeting / Closing
12:00			Lunch		
12:20					
12:40					
13:00		Opening / Welcome talk			
13:20		Space and earth environmental science I	New facility and status report III		
13:40					
14:00					
14:20					
14:40					
15:00					
15:20		Coffee and tea	Coffee and tea		
15:40		Space and earth environmental science II	AMS development / Technical development / Heavy nuclides		
16:00	Registration / Ice Breaker				
16:20					
16:40					
17:00					
17:20			Poster session		
17:40		Poster session			
18:00				Gala Dinner (THE KAWABUN NAGOYA)	
18:20					
18:40					
19:00					
19:20					
19:40					
20:00					

Dec. 7 (Sat) 8:30-18:30 :
Post-Conference One-day Trip to Varve Museum and Wakasa Mikata Jomon Museum

NOTES

Presentation Schedule

MONDAY, DECEMBER 2, 2019

16:00 Registration

Ice Breaker

TUESDAY, DECEMBER 3, 2019

8:40 Registration

Pre-session

Chair: T. Nakamura

9:40	**PRE-01**	Progress in AMS and Opportunities for Applications with long-lived Radionuclides	H.-A. Synal
10:00	**PRE-02**	Latest results of the MILEA system - a new 300 kV multi-isotope AMS facility	A.M. Müller, S. Maxeiner, M. Christl, P. Gautschi, H.-A. Synal, C. Vockenhuber, and L. Wacker
10:20	**PRE-03**	New Developments for the MC-SNICS Ion Sources at NEC	M. Sundquist, R. Kitchen, T. Hauser, E. Alderson, A. Gajeski, K. Kearney, S. McNamer, A. O'Conner, A. O'Dwyer, M. Sandlin, and M. Stodola
10:40	**PRE-04**	Recent Progress in Positive Ion Mass Spectrometry (PIMS) for Radiocarbon Measurements	M. Sundquist, S.P.H.T. Freeman, R. Shanks, C. McIntyre, P. Salou, K. Kearney, R. Kitchen, T. Hauser, R. Bosch, and E.C. Alderson
11:00	**PRE-05**	Low energy ^{14}C and multi-element HVE AMS systems	G. Scognamiglio, M. Klein, N. Podaru, and D. Mous
11:20	**PRE-06**	Performance of the HVE 1 MV AMS system for the analysis of actinides and beryllium	G. Scognamiglio, M. Klein, N. Podaru, G. Domínguez, D. Mous, Q. Liu, and X.L. Zhao

11:40 Lunch at Universal Club

13:00	**Opening**	T. Nakamura
	Welcome talk	K. Kusano

Session 1: Space and earth environmental science I

Chair: D. Fink

13:20	**O-01** ***Keynote***	Evidence for solar-flare and other cosmic-ray events in the ^{14}C record in tree rings and in other records	A.J.T. Jull, F. Miyake, and I. Panyushkina
14:00	**O-02** ***Invited***	Simulation of Δ^{14}C peak in AD 775 using MCNPX and Estimation of the occurrence time of the ^{14}C peak in AD 775 Δ^{14}C values in sub-annual tree rings	J. Park, J.-W. Seo, W. Hong, G. Park, K. Sung, Y.J. Park, and Y.-J. Kim
14:20	**O-03**	Variation of cosmogenic ^{10}Be for cosmic ray event in ～5480 BC from Antarctic Dome Fuji ice core	K. Kanzawa, F. Miyake, Y. Tada, K. Horiuchi, K. Ohtani, K. Sasa, Y. Motizuki, K. Takahashi, Y. Nakai, H. Motoyama, and H. Matsuzaki
14:40	**O-04**	Variations of Beryllium-10 and Chroline-36 deposition flux at Tsukuba, Japan	Y. Ochiai, K. Sasa, Y. Tosaki, T. Takahashi, M. Matsumura, and K. Sueki
15:00	**O-05**	Distribution of atmospheric concentrations of ^{7}Be and ^{10}Be in the marine boundary layer	T. Yamagata, H. Nagai, and H. Matsuzaki

15:20 Coffee and tea

Session 2: Space and earth environmental science II

Chair: H.-C. Li

15:40	**O-06**	Study on the natural iodine isotope system: a consideration from iodine geochemical cycle	H. Matsuzaki
16:00	**O-07**	Screening for Radionuclide Contamination from the Fukushima Accident by Iodine-129 Measurement in Corals from Baler	S.J. Limlingan, A.T. Bautista VII, A.M. Jagonoy, J.M. Racho, B.J. Arcilla, M.M. Bauyon, J.D. Valdez, H. Kusuno, E. Dumalagan Jr., F.P. Siringan, and H. Matsuzaki
16:20	**O-08**	Radiocarbon Releases from the Fukushima Dai-ichi Nuclear Power Plant	S. Xu, B. Chen, Y. Lang, G. Cook, S. Freeman, and P. Naysmith
16:40	**O-09**	Atmospheric $^{14}CO_2$ time series from Point Barrow, Alaska: ending of the “Bomb Radiocarbon Period” in the Northern Hemisphere	X. Xu, J.C. Walker, S. Newman, and S.E. Trumbore

17:00 Poster session

WEDNESDAY, DECEMBER 4, 2019

Session 3: New facility and status report I

Chair: H. Matsuzaki

9:00	**O-10** ***Keynote***	The status report of AMS at CIAE	M. He, Q. Zhao, Y. Bao, Q. You, S. Su, S. Jiang,.Y. Hu, Y. Pang, Y. Zhang, K. Li, X. Wang, S. Wu, F. Wang, and Q. Meng
9:40	**O-11** ***Invited***	Present status and application studies in GXNU-AMS Lab	H. Shen, Z. Zhao, Z. Li, M. Liu, M. Qi, S. Wei, Y. Bao, M. He, K. Sasa, and S. Jiang
10:00	**O-12** ***Invited***	Progress report and some applications of the NTUAMS Lab during 2017-2019	H.-C. Li, S.-C. Kang, C.-Y. Chou, and T. Chang

10:20 **Coffee and tea**

Session 4: New facility and status report II

Chair: H. Shen

10:40	**O-13** ***Invited***	Status Report of Current Performance of KIGAM AMS Laboratory	W. Hong, J. Park, G. Park, Y. Park, and K. Sung
11:00	**O-14** ***Invited***	Current status of 6MV AMS Research at KIST	G.-H. Lee, M.-S. Oh, S.E. Song, J.H. Song, J.A. Eliades, J. Kim, J.Y. Kim, S.R. Seo, and B.-Y. Yu
11:20	**O-15**	Status of KOMAC-AMS	Y.-S. Cho, K. Choe, Y.S. Ha, and K.-R. Kim
11:40	**O-16**	AMS for New drug development support at KRICP in KIRAMS	J. Song, S. Dueker, C. Yeo, S. Bae, J.B. Park, and J. Shim

12:00 **Lunch at Universal Club**

Session 5: New facility and status report III

Chair: J.-K. Kim

13:20	**O-17**	Status of the MALT-AMS system and analysis of environmental nuclides produced by the human nuclear activity	H. Matsuzaki, H. Tokuyama, T. Yamagata, Y.S. Tsuchiya, H. Kusuno, M. Toya, M. Kawamoto, T. Tanii, Y. Miyake, K. Nakashoji, and A.T. Bautista VII
13:40	**O-18**	Progress of Ultrasensitive Detection Techniques for the 6 MV multi-nuclide AMS System at the University of Tsukuba	K. Sasa, T. Takahashi, M. Matsumura, Y. Ochiai, T. Matsunaka, A. Sakaguchi, H. Shen, and K. Sueki
14:00	**O-19**	Present status of JAEA-AMS-TONO in 2019	N. Fujita, A. Matsubara, M. Miyake, T. Watanabe, Y. Saito-Kokubu, M. Kato, N. Okabe, N. Isozaki, C. Ishizaka, T. Nishio, A. Nishizawa, A. Shimada, and N. Ogata
14:20	**O-20**	A status report on a Single Stage Accelerator Mass Spectrometry at the Atmosphere and Ocean Research Institute, The University of Tokyo	Y. Yokoyama, T. Aze, Y. Miyairi, C. Sawada, Y. Ando, S. Izawa, and Y. Ueno
14:40	**O-21**	Radiocarbon dating at The University of Tokyo	M. Yoneda, H. Ozaki, and T. Omori
15:00	**O-22**	Present status and application studies with HVE ^{14}C AMS system at Nagoya University (2017/18/19)	T. Nakamura, M. Minami, H. Oda, A. Ikeda, M. Yamane, M. Nishida, Y. Wakasugi, R. Sato, H. Sawada, and H. Kitagawa

15:20 **Coffee and tea**

Session 6: AMS development / Technical development / Heavy nuclides

Chairs: W. Hong

15:40	**O-23**	Research on Miniaturized AMS Measurement of ^{129}I	Q. Zhao, M. He, Y. Pang, J. Gong, Y. Bao, Q. You, K. Li, S. Su, and Y. Hu
16:00	**O-24**	Low Energy AMS for ^{10}Be and ^{26}Al at Tianjin University	K. Dong, S. Xu, and Y. Lang
16:20	**O-25**	Limits of sensitivity in Actinides AMS	M.A.C. Hotchkis, D.P. Child, M. Froehlich, D. Koll, A. Wallner, and M. Williams
16:40	**O-26**	Cryogenic trapping of CO_2 in the presence of other gases	B. Yang, R. Kazemi, and A.M. Smith
17:00	**O-27**	The sample preparation and the ICP-MS and AMS measurement of uranium at MALT	L. Zheng, H. Matsuzaki, M. Toya, T. Yamagata, H. Tokuyama, and Q. Yang

17:20 **Poster session**

THURSDAY, DECEMBER 5, 2019

8:20 **Mid-Conference One-day Trip**

18:00 **Gala Dinner at THE KAWABUN NAGOYA**

FRIDAY, DECEMBER 6, 2019

Session 7: General AMS application / Carbon-14 age calibration and archaeological application

Chairs: W. Zhou

9:00	**O-28** ***Keynote***	Constraining the age of Aboriginal rock art using cosmogenic Be-10 and Al-26 dating of rock shelter collapse in the Kimberley region, Australia	D. Fink, G. Cazes, R.H. Fülöp, and A.T. Codilean
9:40	**O-29** ***Invited***	Expansion and demise of the Angkorian Khmer Empire	Q. Hua, M. Hendrickson, D. Penny, D. Cook, and T. Hall
10:00	**O-30**	Radiocarbon dating Ancient Loulan City	B. Xu, and Z. Gu

10:20 **Coffee and tea**

Session 8: Space and earth environmental science III

Chair: Q. Hua

10:40	**O-31** ***Keynote***	A long time-scale record of East Asian monsoon rainfall from Chinese loess ^{10}Be	W. Zhou, W.J. Beck, X. Kong, and F. Xian
11:20	**O-32**	A high-resolution radiocarbon dating sand-loess sequence at Yulin, north-central China and East Asian winter monsoon variations	Y. Gu, H. Lu, H. Zhang, C. Liang, and J. Wu
11:40	**O-33**	Determining diurnal fossil fuel CO_2 and biological CO_2 by $\Delta^{14}CO_2$ observation on certain summer and winter days at Chinese background sites	Z. Niu, and W. Zhou
12:00	**O-34**	Chemometric Analysis of ^{14}C and Fourier Transform Infrared Spectra to improve the chronology of Lake Biwa sediment core	H. Kitagawa, W. Hong, A. Hayashida, and K. Takemura

12:20 **Business meeting**
Closing

Poster session

Tuesday, December 3, 17:00 - 18:40
Wednesday, December 4, 17:20 - 18:40

New facility and status report

P-01	A new compact radiocarbon AMS (MIni CArbon DAting System) recently installed at Nanjing University	Z. Hongyan, G. Yao, L. Chenghong, and L. Huayu
P-02	Research and performance with YU-AMS system	T. Moriya, M. Takeyama, H. Sakurai, H. Miyahara, M. Ohyama, H. Saitoh, Y. Okada, and F. Tokanai
P-03	Status report of the compact AMS facility at GIG, CAS	S. Zhu, Z. Cheng, P. Ding, N. Wang, Y. Sun, G. Zhang, and C. Shen
P-04	MALT Accelerator Report 2019	H. Tokuyama, H. Matsuzaki, Y. Tsuchiya, H. Kusuno, M. Toya, T. Yamagata, M. Kawamoto, L. Zhen, Y. Qi, L. Wang, T. Tani, Q. Yang, Y. Miyata, N. Miyauchi, A. Horiuchi, and K. Yoshida
P-05	A New Accelerator Mass Spectrometry Facility in Qingdao National Laboratory for Marine Science and Technology, China	X. Wang, S. Sun, Y. Xue, and H. Song
P-06	Status of the QNLM-AMS facility and the process blank assessment of small sized samples for ^{14}C analysis	S. Sun, L. Xu, Y. Xue, H. Song, and X. Wang
P-07	Current status of the compact-AMS system at Paleo Labo Co., Ltd.	S. Itoh, M. Sato, M. Hirota, Z. Lomtatidze, H. Yamagata, and K. Nakamura
P-08	Performance of a newly installed MICADAS at the Ocean University of China	Z. Wang, H. Zhang, X. Ning, X. Xu, H. Li, and M. Zhao
P-09	OUC-CAMS：An introduction of the MICADAS installed at the Ocean University of China	H. Zhang, X. Ning, Z. Wang, X. Xu, H. Li, and M. Zhao
P-10	AMS program in Tianjin University	Y. Lang, L. Cui, K. Dong, M. Zhang, J. Zhong, and S. Xu
P-11	A new capability for ^{41}Ca analysis using CaF_3^- at the Xi'an-AMS	Y.-C. Fu, W.-J. Zhou, P. Cheng, and L. Zhang

Technical development

P-12	A Study of Surface Stripper for the AMS System with a Footprint below 2 m × 2 m	A. Matsubara, N. Fujita, and K. Kimura
P-13	Ion Source development at the compact AMS at PKU	X.F. Ding, D.P. Fu, L.P. Zhou, and K.X. Liu
P-14	A performance report of the automatic pressing machine developed at the Atmosphere and Ocean Research Institute, The University of Tokyo	C. Sawada, Y. Yokoyama, Y. Miyairi, and T. Aze
P-15	Development of an automated system for conventional ABA treatment	K. Sung, W. Hong, G. Sung, Y. Park, J. Park, and G. Park
P-16	New procedure of CO_2 extraction for radiocarbon analysis of DIC in water samples at Nagoya University and Geological Survey of Japan	H.A. Takahashi, H. Handa, M. Minami, R. Sato, and T. Nakamura

Space and earth environmental science

P-17	Halogen isotopes analysis in Greenland SE dome ice core	M. Toya, H. Matsuzaki, K. Horiuchi, Y. Iizuka, A.T. Bautista VII, L. Wang, and W. Xiao
P-18	Interpreting ^{10}Be records in sediments with a chemometric analysis of optical properties	M. Yamane, Y. Yokoyama, H. Matsuzaki, K. Takemura, and H. Kitagawa
P-19	Tracing study and source analysis of atmospheric fossil fuel CO_2 by radiocarbon and air pollutants in Xi'an, China	Y. Hou, W. Zhou, P. Cheng, and X. Xiong

Carbon-14 age calibration and archaeological application

P-20	Potential ^{14}C excursions in the available radiocarbon calibration curve data	J. Pawlyta, and A. Rakowski
P-21	Applications of Miyake effect in construction of absolute dendrochronological scale	A. Rakowski, M. Krąpiec, J. Pawlyta, and D. Wiktorowski
P-22	775 and 994 ^{14}C event in the tree-rings of northern Japanese trees	M. Hakozaki, F. Miyake, and T. Nakamura
P-23	Radiocarbon dating of a shrine pavilion and offerings at Abushina shrine in Gifu prefecture, Japan	Y. Saito-Kokubu, T. Nisio, N. Fujita, and A. Matsubara
P-24	AMS ^{14}C dating on Collagen, TOC and carbonate of bone and tooth samples at the NTUAMS Lab	C.-Y. Chou, H.-C. Li, S.-C. Kang, and T. Chang
P-25	The spatial distribution of shell ^{14}C ages in China.	P. Cheng, and J. Dong
P-26	Radiocarbon dating and diet analysis of cremated bones excavated from archaeological sites in Japan	M. Minami, S. Wakaki, H. Mukumoto, and T. Nakamura

General AMS application

P-27	A plan on accurate radiocarbon dating of ivory products in Japan and estimation of the original areas for providing ivory for legal international trading of ivory products	T. Nakamura, H. Koike, M. Minami, and S. Nishida
P-28	Radiocarbon ages of organic carbon in sediments, suspended particles, and benthic invertebrates in Otsuchi Bay, northeastern Japan	N. Satoh, H. Fukuda, M. Hirose, Y. Miyairi, Y. Yokoyama, and T. Nagata
P-29	Radiocarbon ages of POC, DOC, and DIC in ground ice in Siberian permafrost	R. Sato, M. Minami, G. Iwahana, and T. Hiyama
P-30	A ^{129}I/^{127}I data collection of marine biota	H. Kusuno, H. Matsuzaki, M. Toya, and H. Tokuyama
P-31	Preliminary test for ^{129}I measurement of $CaCO_3$ samples in JAEA-AMS-TONO	T. Mitsuguchi, N. Okabe, M. Miyake, A. Matsubara, N. Fujita, T. Watanabe, and Y. Saito-Kokubu
P-32	Iodine-129 time series records from coastal Taiwan	G.S. Burr, H. Matsuzaki, B.-S. Wang, H. Kusuno, H. Tokuyama, and Y. Takeyasu
P-33	Holocene activity of the Sagiriko fault detected from sediment cores and a ground penetrating radar profiling, Izu Peninsula, central Japan	H. Kimura, T. Nakanishi, M. Yukawa, T. Hosoya, S. Ki-Suck, and W. Hong
P-34	Radiocarbon age offsets of plants and shells in the Holocene sediments from the Lake Harutori, Pacific coast of Hokkaido, northeast Japan	T. Nakanishi, W. Hong, K. Shigeno, and F. Nanayama
P-35	Marine reservoir effects in transgressive sediments from the Miyazaki Plain, southeast coast of Kyushu, Japan	T. Nakanishi, M. Niwa, N. Okabe, M. Kato, A. Matsubara, and N. Fujita
P-36	Bomb Δ^{14}C record of a Tridacna gigas from South China Sea: chronology and paleoceanography studies	C.Y. Lin, and H.C. Li
P-37	Small sample graphitization for ^{14}C dating using EA-AGE3 at JAEA-AMS-TONO	T. Watanabe, Y. Saito-Kokubu, N. Fujita, C. Ishizaka, T. Nishio, A. Matsubara, M. Miyake, N. Isozaki, and A. Nishizawa
P-38	1.2-MV Carbon AMS Experiment in KOMAC-AMS	K.-R. Kim, Y.S. Ha, K. Choe, and Y.-S. Cho
P-39	AMS Preteatment Method for Biosample Analysis in KRICP	C.S. Yeo, J.H. Song, S. Dueker, and J.H. Shim
P-40	Assessing problems of AMS ^{14}C dating on peat samples by dating Carex species	S. Kashyap, H.-C. Li, H.-L. Zhang, Z.-C. Wang, and X.-Y. Ning
P-41	Chronology construction of a stalagmite from southwest China by ^{14}C, ^{230}Th/U and ^{210}Pb dating methods	M.-Q. Liang, H.-C. Li, H.-S. Mii, and Z.-B. Ma
P-42	Using ^{14}C dated stalagmite records to reconstruct paleoclimate change in South Siberia	Y.-S. Chen, H.-C. Li, J.-J. Yin, H.-S. Mii, T. Blyakharchuk, and C.-C. Shen

Guides for Presentation and Proceedings

Posters:

The size of the presentation board is 170 cm high and 120 cm wide. Posters can be on the board from the start (Tuesday morning) till the end (Friday 13:00) of the symposium. After Friday 13:00, all posters leaving on the board will be shredded.

Oral Presentations:

Please bring your own computer for presentation. If it is impossible to bring it, please consult to the EA-AMS 8 organizing committee in advance.

Keynote lectures: 35 min + 5 min for Q&A (40 min in total).
Invited and other oral presentations: 15 min + 5 min for Q&A (20 min in total).

Proceedings:

All presenters have an opportunity to publish short paper (2-4 pages, written in English or Japanese) in the Proceedings of the 22nd Japanese symposium on Accelerator Mass Spectrometry (JAMS-22). We are planning to publish the Proceedings by April, 2020. We welcome submission of proofread manuscript from all the participants, using a web online system (https://www.nendai.nagoya-u.ac.jp/eaams8/proceedings.html) by February 28, 2020.

NOTES

Abstracts

Oral presentation

Pre-session

PRE-01

Progress in AMS and Opportunities for Applications with long-lived Radionuclides

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The technical evolution of Accelerator Mass Spectrometry (AMS) instrumentation over the last ten years has boosted research with radioactive tracers in global environment. Of course, ^{14}C has been and still is the by far most important AMS nuclide but there is a great potential for applications of ^{10}Be, ^{26}Al, ^{36}Cl, ^{41}Ca, ^{129}I, and actinides measurements. Today, 1+ charge state is primarily used in case of ^{14}C detection, molecular interferences are destroyed in multiple collisions with He stripper gas atoms, and a high yield of atomic ions is reached at energies of a few hundred keV, only. Thus, instruments develop towards lab size or table-top devices and performance has improved with respect to overall detection efficiency and reproducibility of measurement conditions. In addition, the advent of hybrid ion source accepting sample materials as CO_2 in a He carrier gas stream [1] enabled the analysis of microgram sized samples making compound specific analyses possible.

He stripping has the potential to down size instruments for measurements of other radionuclides, too [2]. For the ^{10}Be/^{10}B pair, a significant isobar separation capability can be achieved already at particle energies of less than 1 MeV, by using passive absorber techniques and exploiting the quite large difference in energy loss of these isobar [3]. Apart from this, only nuclides that are not interfered by nuclear isobars can be detected with new compact instruments. Modern simulation technique allows to optimize their designs and replace traditional accelerator technology by high-voltage platforms driven by commercial HV power supplies. These developments have launched the wide spread use of AMS in various research fields and has resulted in a boom of new AMS facilities which impact the wide variety of applications of AMS in modern research.

The recent technical development will be summarized and examples on specific applications will be discussed to highlight future perspective of research with long-lived radionuclides.

Keywords: *AMS; Radiocarbon; Long-lived radionuclides*

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Pre-session

PRE-02

Latest results of the MILEA system - a new 300 kV multi-isotope AMS facility

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In 2018 a prototype version of a new compact multi-isotope AMS instrument, the so-called MILEA (Multi Isotope Low Energy AMS), was taken into operation at the Laboratory of Ion Beam Physics at ETH Zurich in collaboration with Ionplus. The system operates at accelerator voltages below 300 kV and is dedicated to the measurement of ^{10}Be, ^{14}C, ^{26}Al, ^{41}Ca (biomedical applications), ^{129}I and actinides (Pu, U, Th and others).

In the course of developing MILEA, various technological and ion optical concepts of the well-established MICADAS and Tandy spectrometers were combined and refined for the application in this new multi-isotope system. Moreover, new approaches and developments have been implemented in order to optimize the performance for all nuclides. Consequently, a very small system footprint could be realized ($3.5\times7\text{m}^2$).

A MICADAS type Cs-sputter ion source is used for the extraction of all elements, followed by an 90° electrostatic deflector and a 90° magnet, which constitute the low energy spectrometer. The accelerator consists of a vacuum insulated terminal supplied by a 300 kV cascade [1]. In order to optimize the measurement performance, ion beam transmission and background for all nuclides, the design of the stripper is crucial [2].

Since the focusing properties of the high energy accelerator stage depends on the charge state and the molecular fragmentation after the stripper, a quadrupole triplet lens was installed to achieve optimal beam coupling to the HE spectrometer, which consists of a 90° magnet, 120° ESA and 110° magnet. Finally, a high resolution ΔE-Eres gas ionization chamber equipped with a removable absorber cell is mounted at the back end.

Extensive tests and experiments have been performed in order to determine and demonstrate the measurement performance of the system for the mentioned radionuclides. Based on these findings a commercial version of the MILEA facility has been established by Ionplus. An overview of the most important system features will be given and the latest results obtained will be presented and discussed.

Keywords: *multi-isotope; low-energy; AMS*

References

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Pre-session

PRE-03

New Developments for the MC-SNICS Ion Sources at NEC

Mark Sundquist, Richard Kitchen, Thilo Hauser, Eric Alderson, Andrew Gajeski, Kenneth Kearney,
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We will describe and report performance of new NEC equipment to enhance the convenience, precision, and reliability of the over 160 existing and new MC-SNICS ion sources[1] . This equipment includes a microprocessor-controlled MC-SNICS indexer controller, an electric cathode press, an absolute position system for the MC-SNICS, a gas sample hub (GSH), and an automated gas ampoule transfer system (AGATE). The MC-SNICS variations, their applications, and other new developments will be discussed.

Keywords: *MC-SNICS; indexer; cathode; press*

References

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Personnel, Santa Fe, New Mexico, October 16019, 1991, Singapore: World Scientific, 1992, pp. 295-301

Pre-session

PRE-04

Recent Progress in Positive Ion Mass Spectrometry (PIMS) for Radiocarbon Measurements

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We will present recent performance data from the PIMS system at SUERC, along with the description and status of new complementary instruments to facilitate and automate direct CO_2 radiocarbon measurements, including a CO_2 Gas Sample Hub (GSH) and an Automated Gas Ampoule Transfer Engine (AGATE).

Keywords: *PIMS; radiocarbon; CO_2; hub, ampoule*

Pre-session

PRE-05

Low energy ^{14}C and multi-element HVE AMS systems

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Two new sub-MV accelerator mass spectrometers based on vacuum insulated accelerators were designed, manufactured and tested by High Voltage Engineering.

The first is dedicated to ^{14}C measurements [1]. The system features a low-memory hybrid SO110-C sputter ion source, an injector magnet, an accelerator operating at a terminal voltage of 210 kV, an analyzer magnet, an electrostatic analyzer (ESA) and a gas ionization chamber (GIC), and has a total footprint of 3.0 m x 2.7 m. Both low- and high-energy mass analyzers use temperature compensated permanent magnets. Several feedback loops ensure stable beam position in both the low- and high-energy side, eliminating effects of long-term drifts (e.g. temperature) on the analysis result. Novel to ^{14}C AMS, the accelerator terminal is equipped with a so-called charge state selector (CSS). Following the stripping process in the accelerator, ions with charge state 1+ have the highest yield and are used for the AMS measurement. In conventional systems, ^{12}C and ^{13}C ions of other charge states undergoing charge exchanges within the second acceleration stage are the dominant sources of measurement background. The CSS filters out these contributions, resulting in a ^{14}C/^{12}C background ratio of $5 \cdot 10^{-16}$.

The second system is a multi-element AMS apparatus for ^{10}Be, ^{14}C, ^{26}Al, ^{129}I, and actinides, featuring the SO-110C ion source, a low-energy spectrometer with ESA and analyzing magnet, and a high-energy analyzer comprising one ESA, two analyzing magnets and a GIC. For all elements, the accelerator runs at 300 kV. The system footprint is 6.9 m x 5.0 m.

We will discuss the performance of both AMS systems and highlight the technical features enabling low background measurements.

Keywords: *Low-energy AMS; radiocarbon; multi-element*

References

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Pre-session

PRE-06

Performance of the HVE 1 MV AMS system for the analysis of actinides and beryllium

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HVE has designed, manufactured and tested an AMS system with two new high-energy detection beamlines, supporting analyses of elements from ^{3}H to ^{244}Pu at 1 MV terminal voltage [1].

The beam is created in a hybrid, low-memory sputtering SO-110C ion source. The injector has an ESA and a high-resolution magnet. The 1 MV Tandetron™ accelerator features a special stripper geometry with a differential pumping arrangement and two turbo-molecular pumps. Either Ar or He can be selected as stripper gas. The high-energy spectrometer comprises a first analyzing magnet, an ESA, and two detection beamlines. Each of these lines features a magnet, a gas ionization chamber and other components for beam focusing or background suppression.

The first beamline is dedicated to ^{10}Be AMS. A SiN degrader foil is placed in front of a high-acceptance magnet (30 mrad), providing a ^{10}B suppression of 4 orders of magnitude. The beam interaction with the foil results in charge state distribution, angular straggling and energy straggling, which convert in beam losses. However, due to the magnet high acceptance, the overall efficiency (including both charge state yields and optical losses) is up to 20%. A set of vertical steerers following the degrader foil suppresses interfering ^{10}B ions which charge-exchange between the foil and the detector, resulting in a background in the low 10^{-16} level.

The second beamline is designed for actinides AMS, which requires the cyclical measurements of several isotopes in the detector. All the analyzing components (magnets and ESA) in the beamline for actinides have a bouncing capability, allowing a fast sequential measurement of the isotopes to the measuring device. The transmission through the accelerator is 30% with He stripping, and the ^{236}U/^{238}U background ratio is $8 \cdot 10^{-15}$. This beamline supports the AMS measurement of ^{3}H, ^{14}C, ^{26}Al, ^{41}Ca, and ^{129}I.

The magnets have been designed and built by HVE to meet the requirements of the different beamlines (high resolution, high angular acceptance for the ^{10}Be beamline, bouncing capability and transport of ^{244}Pu at 1 MV for the actinides beamline). Optical aberrations are minimized by high-order corrections.

Acknowledgements

The project was supported by the Interdiscipline Research Funds of the Beijing Normal University (2017NJCB03) and the Special Funds to Coordinate Development of World-class Universities and First-class Disciplines Construction by Ministry of Finance of the People's Republic of China.

Keywords: *AMS; multi-element; magnet design*

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Space and earth environmental science I

Keynote

O-01

Evidence for solar-flare and other cosmic-ray events in the ^{14}C record in tree rings and in other records

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Various ^{14}C excursions apparently caused by an increase of incoming cosmic rays on a short time scale found in the Late Holocene have generated widespread interest and have been reproduced in many different tree-ring records [1-4]. These excursions at AD 774-775 AD 993-994 are well-documented but with an increasing number of studies using annual ^{14}C analysis a range of new structures are being revealed. This includes rapid increase events such as at 660 BC [5,6] likely also due to extreme solar proton events (SPE). However, other types of change in ^{14}C production may be due to a mix of SPE and different phenomena, such as around 5480 BC [3] and 815 BC [7] . A proposed event about 3371 BC [8] was also attributed to SPE effects, but this has not yet been confirmed in other records. Recently, Dee *et al.* [9] and Terrasi *et al.* [10] have explored possible supernova effects, although evidence for ^{14}C production from supernovae is still unclear. A diverse range of processes have the potential to effect cosmic-ray flux, including solar events, gamma-ray bursts, geomagnetic shifts and supernova. Such studies are providing a wealth of new information through which to characterize new 'events' in ^{14}C structure and to begin to understand the processes behind them. This research has much modern relevance in terms of understanding solar-climate forcing as well as the potential damages to technology brought about by events such as solar flares. These effects are also highly relevance to dating using the current international radiocarbon calibration curve based on decadal data. The difference in the shape of a calibration curve based on annual data demonstrates potential to improve the calibration process using annually-derived data, but also indicates that error ranges will likely be increased with a more noisy curve which features the range of structural variability. In addition to the possible effects on radiocarbon calibration, the records of cosmic events observed using other radionuclides (e.g. ^{10}Be and ^{36}Cl) in ice cores (^{10}Be and ^{36}Cl) and the long-term record on the Moon are also instructive for our understanding of solar cosmic-ray variability.

Keywords: *carbon-14; solar flares; supernovae; calibration*

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Space and earth environmental science I

Invited

O-02

Simulation of Δ^{14}C peak in AD 775 using MCNPX and Estimation of the occurrence time of the ^{14}C peak in AD 775 Δ^{14}C values in sub-annual tree rings

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Since Δ^{14}C peak (M12) in AD775 was measured annually by Miyake *et al.* [1], many researchers have been interested in this theme. The M12 and AD 993/4 become thought to be from Solar Proton Event (SPE), since ^{10}Be/^{36}Cl measured in polar ice cores [2]. In this study first GCR and SPE was simulated using MCNPX code and recent measured SPE and GCR energy spectrum. Energy spectrum related to SPE softer than those related to GCR, so ^{14}C production heights from SPE are higher than those from GCR according to MCNPX simulation. This difference can suggest a clue for which one is more plausible between SPE and GCR. Second I introduce the Δ^{14}C values in early- and latewood from AD 762–776 Zelkova serrata tree rings from Bangu-dong, Ulsan, South Korea (35° 33'N, 129° 20'E). The half-oxidation time of ^{14}C was estimated from a detailed analysis of a small bomb peak in AD 1962. Based on the half-oxidation time, the Δ^{14}C rise in the latewood, but not in the earlywood, of AD 774 in Finland, and the absence of a Δ^{14}C rise in both the early- and latewood of AD 774 in South Korea, the ^{14}C spike production was estimated to occur from late April to mid-June in AD 774.

Keywords: *M12; sun-annual tree rings; SPE, MCNPX*

References

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Space and earth environmental science I

O-03

Variation of cosmogenic ^{10}Be for cosmic ray event in ~5480 BC from Antarctic Dome Fuji ice core

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Cosmogenic nuclides, such as ^{10}Be, ^{14}C and ^{36}Cl, are produced by interactions between cosmic ray particles and atmospheric atoms. After productions of these nuclides in the atmosphere, they are stored in archive samples, e.g., tree rings for ^{14}C and polar ice sheets for ^{10}Be and ^{36}Cl. Therefore, cosmogenic nuclides data in these archive samples would record cosmic ray intensities in the past.

A rapid and quite large increase of ^{14}C concentrations around 5480 BC was found by annual ^{14}C analyses using a bristlecone pine sample (~5480 BC event) [1]. An increase rate of ^{14}C concentrations for the ~5480 BC event is 17‰/8 years, which is a much rapider change compared with normal annual ^{14}C variations including large ^{14}C increases during several grand solar minima. The ^{14}C variation is also different from other cosmic ray events shown in cosmogenic data, i.e., the 774/775, 993/994 (992/993), and ~660 BC events [2-4]. Several hypotheses for an origin of the ~5480 BC event have been proposed, i.e., a sudden decrease of solar magnetic activity and an occurrence of consecutive extreme Solar Proton Events (SPEs), however, further investigations are necessary to specify the origin.

To investigate the origin of the ~5480 BC event, we analyzed ^{10}Be concentrations in Antarctic Dome Fuji ice cores with quasi-annual resolution. We prepared BeO samples, and carried out AMS measurements at the University of Tokyo (MALT-AMS). We found a large increase of ^{10}Be concentrations in 1–2 years around 5468 BC (+10yrs/-15yrs). Although this ^{10}Be increase might have the same origin with the ~5480 BC event, we could not confirm a similarity between ^{10}Be and ^{14}C variations before and after the rapid increase due to a lack of measurement period of ^{10}Be data. In order to fully cover the period of the ~5480 BC event taking into account the age error, we are going to analyze ^{10}Be for a longer time period (~100 years in total) in the future.

Keywords: *Cosmogenic nuclides; Beryllium-10; Cosmic ray event*

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[4] Park *et al.*, Radiocarbon 59 (2017) 1147.

Space and earth environmental science I

O-04

Variations of Beryllium-10 and Chroline-36 deposition flux at Tsukuba, Japan

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Beryllium-10 (half-life: 1.35 Ma) and Chlorine-36 (half-life: 0.301 Ma) are cosmogenic nuclides, that are produced by nuclear reactions between cosmic rays and elements consisting of the earth. The deposition fluxes of cosmogenic Beryllium or Chlorine were expected to be used for the atmospheric tracer or indicator of cosmic ray intensity. However, variations of fluxes were complicated because of the contribution to various factors such as the local atmospheric conditions. Long term measurements were needed to clarify the trends of fluxes. We had collected monthly rainwater samples at Tsukuba, Japan during 2014-2018 and analyzed Beryllium-10 and Chlorine-36 with accelerator mass spectrometry at UTTAC. The deposition flux of Beryllium-10 ranged from 67 ± 2 to $(1.16\pm0.02)\times10^3$ atoms m^{-2} s^{-1}, and averaged $(4.42\pm0.04)\times10^3$ atoms m^{-2} s^{-1}. The deposition flux of Chlorine-36 ranged from 2 ± 1 to $(1.4\pm0.1)\times10^2$ atoms m^{-2} s^{-1} and averaged 30 ± 1 atoms m^{-2} s^{-1}. The fluxes in this study were higher than the estimated value of Beryllium (350-400 atoms m^{-2} s^{-1}[1]) or global mean productions (Beryllium-10, 290 atoms m^{-2} s^{-1}[1]; Chlorine-36, 25 atoms m^{-2} s^{-1}[2]). The meteorological conditions like precipitation amounts would affect the deposition amounts. The Beryllium-10 deposition flux had the correlation with the Chlorine-36 ($r = 0.6$, $p < 0.05$). The behavior of Beryllium-10 would be similar to that of Chlorine-36 in the environment. The ratio of Beryllium-10 to Chlorine-36 averaged 23 ± 2, which was higher than the estimated ratio of 11.6 based on the production rate [2]. The re-suspended soils were possibly to be caused by the high ratio because soils have a high level of Beryllium-10 concentration (e.g. 2×10^8 atoms g^{-1} in Japan [3]). In this presentation, we would report the variations of the Beryllium-10 and Chlorine-36 deposition flux in detail and the correlations with the solar activity.

Keywords: *Beryllium-10; Chlorine-36; rainwater; flux; variation; AMS*

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Space and earth environmental science I

O-05

Distribution of atmospheric concentrations of ^{7}Be and ^{10}Be in the marine boundary layer

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The distribution of atmospheric concentrations of ^{7}Be (Half-life 53.3 days) and ^{10}Be (Half-life 1.36 Ma) in marine boundary layer was investigated using a high-volume air sampler onboard of several cruises of the R/V Hakuho-maru. The cruises are 1) KH94-4 in the Western Pacific in 1994, 2) KH96-5 in the Eastern Indian Ocean in 1996, 3) KH03-1 in the Eastern South Pacific in 2003, 4) KH04-5 in the Southern Pacific in 2004, 5) KH09-5 in the Western Indian Ocean and 6) KH12-4 in the North Pacific in 2012. The concentration of ^{7}Be in samples were measured using by HPGe detectors. The concentration of ^{10}Be were measured using ^{10}Be-AMS system on MALT, The university of Tokyo.

Low ^{7}Be concentrations were observed in the Antarctic low-pressure zone between 40° and 50° and the Equatorial region. High ^{7}Be concentration were observed between 20° and 30° in both hemispheres. Temporal variations of the concentration of ^{7}Be in each cruise were corresponded with the variations of atmospheric pressure. It caused the low ^{7}Be concentration that the extreme low pressure in Antarctic low-pressure zone inhibit a downward flux from upper troposphere. The updraft by Hadley cell in equatorial zone makes low ^{7}Be concentration in equatorial zone. Only the equatorial region at coastal area in India, high ^{7}Be concentrations were observed that caused by high vertical convection by Indian monsoon. The atomic ratio of ^{10}Be/^{7}Be for a tracer of stratosphere aerosols were high between 20° and 60° in the Southern Hemisphere. In the Northern Hemisphere, the ^{10}Be/^{7}Be didn't show the latitudinal distribution like the Southern Hemisphere but it showed a seasonal variation which was high from February to June similar to the variation at Tokyo [1].

Keywords: *^{10}Be; ^{7}Be, Atmosphere; Aerosols; Ocean*

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Space and earth environmental science II

O-06

Study on the natural iodine isotope system: a consideration from iodine geochemical cycle

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Before 1950's, the sources of iodine-129 (half-life = 15.7 myr) are limited to those of natural processes, i.e., the interaction of cosmic ray and the spontaneous fission of naturally existing uranium. The production rate should not have been changed drastically for long time, and geochemical circulation time of iodine is generally shorter than its half-life, people has been considering there has been an equilibrium isotopic ratio ($^{129}I/^{127}I$) in a steady state, that enables "dating" with this isotope system like $^{14}C/^{12}C$ system. U. Fehn and J. Moran proposed 1.5×10^{-12} as the equilibrium $^{129}I/^{127}I$ ratio based on the measurements of seafloor sediments around the North and the South American continents. They and their followers had determined "isotope ages" of several brines and pore waters associated with gas hydrates. Typical age calculated from the iodine isotopic ratio was around 50 million years, however in most cases the "geologic age" of the mother strata were much younger, typically few million years.

To examine this discrepancy, the author previously measured the iodine isotopic ratio of deep sea water in the Indian ocean, which was thought to preserve pre-anthropogenic environment, and found one order smaller results than Fehn and Moran value, i.e., $^{129}I/^{127}I = 2.0\times10^{-13}$.

To interpret this result, the author examined the geochemical cycle of iodine again. Though there are few data about not only the dynamics of iodine in various geochemical sites (atmosphere, shallow ocean, deep ocean, sea floor sediments, land soil, biomass, etc.) but also the abundance, a steady state with incomplete iodine mixing between ocean and sediments resulting in different isotopic ratio is possible with certain parameters of iodine dynamics. The dating using iodine isotopic ratio ($^{129}I/^{127}I$) is not simple and the interpretation of the observed ratio should be more careful.

This presentation is an update report of that presented in EA-AMS7 including more detailed consideration about the iodine geochemical cycle.

Keywords: *^{129}I; Iodine isotope system; iodine geochemical cycle*

Space and earth environmental science II

O-07

Screening for Radionuclide Contamination from the Fukushima Accident by Iodine-129 Measurement in Corals from Baler

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Following the Fukushima Daiichi nuclear power plant accident of 2011, excessive amounts of toxic radioactive fallout material was deposited into the Pacific Ocean, consequently posing health risks to exposed individuals. Subsequent transport of this discharge material via circulation in the Pacific Ocean may eventually bring the radionuclides within the vicinity of Philippine coastal communities, possibly endangering marine life, aquatic livelihood, and domestic health. The research study was thus commenced to assess the degree and geographical extent of locally relevant contamination with the use of iodine-129 as an environmental proxy for anthropogenic radionuclide transport. In this study, we present a time series profile of ^{129}I/(stable)^{127}I isotopic ratios in coral cores from the first of three target sites along the northeastern seaboard of the Philippines[1]. Coral cores were collected from Baler, Aurora, age-modeled, and subsequently subsampled per annual growth band. Iodine was then extracted from the calcium carbonate coral matrix via multi-stage solvent extraction procedures and analyzed via Accelerator Mass Spectrometry (AMS) and Inductively Coupled Plasma Mass Spectrometry (ICP-MS)[2]. ^{129}I/^{127}I peaks corresponding to historical nuclear events such as the extensive above-ground bomb testing in the Pacific Proving Grounds (1952, 1954, 1956, 1958, 1962) and the Chernobyl Accident of 1986 (1998, with 12-year time lag) were clearly observed. Moreover, peaks from the Fukushima fallout may have been observed at around 2014, suggesting a three-year transport period via the Kuroshio Recirculation Gyre (KRG). However, with high background ^{129}I/^{127}I levels in recent years (2000 – 2010) as well as the possibility of the signal coming from radioactive material being transported by the North Equatorial current (NEC), further validation from the study's two other geographical sites is still necessary.

Keywords: *iodine-129; Fukushima; coral; nuclear accident*

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Space and earth environmental science II

O-08

Radiocarbon Releases from the Fukushima Dai-ichi Nuclear Power Plant

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Radiocarbon activities have been measured in annual tree rings from Japanese cedar trees (Cryptomeria japonica) collected at various sites ranging from 1–50 km northwest, southwest, south and north of the Fukushima Dai-ichi nuclear power plant (FDNPP). The ^{14}C specific activity varied from 280 Bq/kg C in 2010 to 226 Bq/kg C in 2015. The elevated ^{14}C activities in the 2009 and 2010 rings confirmed ^{14}C discharges during the routine operations of the FDNPP, whereas those activities that were indistinguishable from background in 2012–2015 coincided with the permanent shutdown of the reactors after the accident in 2011. High-resolution ^{14}C analysis of the 2011 ring indicated ^{14}C releases during the Fukushima accident.

The resulted ^{14}C activity decreased with increasing distance from the FDNPP, in particular along the northwest direction. The maximum ^{14}C activity released during the period of the accident was measured 42 Bq/kg C above the natural ambient ^{14}C background in northwest direction. Our findings indicate that, unlike other Fukushima-derived radionuclides (i.e., ^{129}I, ^{131}I, ^{134}Cs, ^{137}Cs), the ^{14}C released during the accident is indistinguishable from ambient background beyond the local environment (~30 km from the FDNPP). Furthermore, the resulting dose rate to the local population from the excess ^{14}C activities is negligible compared to the dose from natural/nuclear weapons sources.

Keywords: *^{14}C release; tree ring; Japanese cedar; FDNPP*

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Space and earth environmental science II

O-09

Atmospheric $^{14}CO_2$ time series from Point Barrow, Alaska: ending of the "Bomb Radiocarbon Period" in the Northern Hemisphere

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The distribution rate and pattern of the bomb ^{14}C produced by nuclear weapons testing during late 1950s – early 1960s has provided a unique opportunity for tracing carbon exchanges in all compartments of the global carbon cycle, and for studying atmospheric dynamics as well. The atmospheric $^{14}CO_2$ content peaked around 1964 which almost doubled the natural level, then since the Test Ban Treaty it has been decreasing as a result of CO_2 cycling between atmospheric, oceanic and terrestrial carbon reservoirs, and by fossil fuel CO_2 emissions. In this century, the dilution of $^{14}CO_2$ content by fossil fuel CO_2 emissions has become the major controlling factor in determining the atmospheric $^{14}CO_2$ decreasing trend.

Long-term observations of ^{14}C variation in atmospheric CO_2 exist for only a few locations. We report here a continuous, high precision and high temporal resolution $\Delta^{14}CO_2$ record obtained at the Point Barrow Observatory, Alaska (71° N, 157° W) from 2003 to 2019. Sample collection was through the NOAA/ESRL flask sampling network program, which enables us to compare radiocarbon data with other trace gases and isotopes, including CO, CO_2 mixing ratios and $\delta^{13}C$ and $\delta^{18}O$ of CO_2. There are distinct seasonal cycles of $\Delta^{14}CO_2$ in this record, with a broad minimum around Mar-Apr and a maximum in Sep-Oct with an amplitude of ~7‰. During the collection period, $\Delta^{14}CO_2$ decreased almost linearly by ~4.3‰/year, and it is passing 0‰ in 2019, indicating ending of the "Bomb Radiocarbon Period" in the Northern Hemisphere.

This iconic event is of global significance because the artificial "aging" of the atmosphere may affect the radiocarbon applications in many different scientific disciplines. Also, given the modeling work of Graven [1] the observed $^{14}CO_2$ data indicate that we are following the worst-case scenario in fossil fuel CO_2 emissions trajectories - the "business-as-usual' emissions (RCP8.5).

Keywords: *bomb-radiocarbon; CO_2; fossil fuel*

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New facility and status report I

Keynote

O-10

The status report of AMS at CIAE

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There are four AMS systems at CIAE which include a large AMS system and three miniaturized AMS systems. The large AMS system(HI-13 AMS system) is set up 30 years ago. The miniaturized AMS systems are set up recent years.

The HI-13 AMS system is based on a big accelerator which can working at terminal voltage of 12MV. There are two beam lines for AMS measurement. Base on the HI-13 AMS system more than 10 radionuclides such as ^{10}Be, ^{36}Cl,^{41}Ca,^{53}Mn,^{60}Fe have been measured.

The three miniaturized AMS systems are home-made system which include a single stage AMS (SS-AMS) system , an Heavy ion tandem AMS (HIT-AMS) and an Multi-nuclides tandem AMS system (MNT-AMS). The SS-AMS is working at terminal of 0.2MV. Based on the SSAMS system, the measurement technique of ^{14}C and ^{3}H have been established. The HIT-AMS is working at terminal voltage of 0.35MV, Based on the HIT-AMS system, the measurement methods for heavy nuclides (such as ^{129}I, ^{236}U, ^{239}Pu) have been developed, and the results shown that the system have excellent performance. The MNT-AMS is working at terminal voltage of 0.30MV, the ^{14}C, ^{26}Al, ^{41}Ca and ^{129}I will be measured with this system. the detail information for the AMS systems and some applications will be introduced.

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Keywords: *miniaturized AMS systems; status report;* ^{14}*C;* ^{129}*I;* ^{239}*Pu*

New facility and status report I

Invited

O-11

Present status and application studies in GXNU-AMS Lab

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GXNU-AMS, a compact ^{14}C accelerator mass spectrometer, jointly developed by the Chinese Institute of Atomic Energy and Guangxi Normal University was installed and commissioned in Guangxi Normal University. Without the traditional mode of SF_6 pressure tank, The terminal of the system was designed as an open insulated high voltage platform, which reduces the construction size of the traditional accelerator to be about 2.5×4.5 square meters. Helium gas stripping was used to eliminate the interference of molecular ions, and the maximum operating voltage was 230KV. At present, the measurement accuracy of the instrument is 0.5%, and the measurement sensitivity is $^{14}C/^{12}C \approx 5\times10^{-15}$ (measurement background is 45,000 years), which can meet the measurement requirements in the fields of life sciences and archaeology. In this paper, the experimental conditions and the lowest possible energy of GXNU-AMS were discussed, as well as several interesting application studies in GXNU-AMS group were presented.

Keywords: *status; GXNU-AMS;* ^{14}C*; low energy*

New facility and status report I

Invited

O-12

Progress report and some applications of the NTUAMS Lab during 2017-2019

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Established in 2013, the NTUAMS Lab owns a 1MV HVEE Tandetron model 4110 Bo accelerator mass spectrometer (AMS) and four graphitization lines. During Nov. 2017 to Oct. 2019, we have run a total of 2349 targets, including 176 OXII, 209 BKG (background for organic carbon samples), 147 NTUB (background for inorganic carbon samples), and 144 inter-comparison samples. The mean $^{14}C/^{12}C$ and $^{13}C/^{12}C$ ratios of OXII for $^{14}C^{3+}$ measurements are $(1.043\pm0.088)E-12$ (n = 170) and $(9.291\pm0.123)E-3$ (n = 170), showing strong correspondence of $^{14}C/^{12}C$ variations to the AMS maintenance. The mean $^{14}C/^{12}C$ ratios of BKG and NTUB are $(6.006\pm2.331)E-15$ and $(5.754\pm2.338)E-15$, respectively. Every batch sample measurement has contained 2-3 known age inter-comparison samples distributed by Glasgow University. The most frequently measured inter-comparison samples, FIRI-L (Consensus value: 2505 yr BP) and VIRI-L (Consensus value: 2234 yr BP), give mean measured ages of 2465 ± 78 (n = 51) and 2222 ± 109 (n = 45), respectively. About 1670 application samples have been measured during the past two years for geological, geographical, oceanographic and archaeological studies. Among those AMS ^{14}C applications, the most significantly academic studies include chronological construction of stalagmites, dating problem of peat samples, dating comparison of multiple components of bone samples, and dating of tree-ring cellulose. Through our efforts, many young (Holocene in age) stalagmites with low U and high Th contents especially stalagmites from Altai mountains in Siberia and caves in northeast China have obtained reliable chronologies. High-resolution and detailed AMS ^{14}C dating on peat cores allows us to find out the cause and mechanism of old carbon influence on peat ^{14}C dating. The measurement of $\delta^{14}C$ records in tree-ring from Philippines and a 40-year Tridacna gigas from South China Sea provides us information about nuclear bomb ^{14}C mixing in the atmosphere and ocean. From these studies, a total of 33 SCI journal papers and 3 MS theses have been published during the past two years. On the maintenance record of our AMS machine, a fault on the GVM due to dust contamination caused a major repair during the past two years.

Keywords: *NTUAMS; OXII and background; inter-comparison; applications*

New facility and status report II

Invited

O-13

Status Report of Current Performance of KIGAM AMS Laboratory

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In autumn of 2007, a 1 MV AMS machine was installed at KIGAM. For the last 12 years, KIGAM AMS has dedicated to research fields such as dominantly earth science, archaeology, anthropology, biomass, criminal investigation, medical science and sitology.

For the sample treatment, an automatic reduction system were developed in 2009. This machine has treated more than 33,000 samples so far by only one operator. A ten-fold oxidation system for carbonate by wet chemistry was also developed in 2014. This system is applied not only to calcium carbonate but also to barium carbonate, strontium carbonate and air samples. For the last two years, ABA Chembot, an automated system for ABA treatment, was developed. Details of this system will be presented at the poster session in this conference.

For the data process, a database system called AMS db was introduced in 2009. All the samples should be registered in the data base, and then the database issues sample codes. AMS db semi-automatically collects most data produced for the sample in our lab. AMS db also automatically calculates radiocarbon ages from raw data, and makes an analysis report. These all are feasible thanks to our unique sample code structure, which implies types of samples and plays a key role in automatic calculation of blanks and oxalic values as well as unknown sample ages. Since very beginning in the history of KIGAM AMS lab, the sample code was designed with taking automatic calculation into consideration.

For the review of results, an AMS data management program, Cheeseburger, was developed in 2011. Cheeseburger is a tiny program (443 kBytes) to collect data needed in age calculation from multiple raw files of AMS and makes a data table. With the table, Cheeseburger calculates radiocarbon ages with errors, blank values, oxalic values, and the detection limit of the AMS system with the statistical information of the whole measurement, so that the performance and the stability of the AMS machine can be figured out. Cheeseburger can be used to inspect the measurement results because the program provides graphs of data such as C-14 counts. In-situ inspection of the measurement provides important information to control the sophisticated conditions of AMS system, and thus enhance the efficiency of AMS measurement. In 2019, Cheeseburger was upgraded to version 7.0 to calibrate a radiocarbon age using Bayesian calculation and IntCal13 data set as well as Korean tree-ring data set.

Keywords: *KIGAM AMS Lab; Status report*

New facility and status report II

Invited

O-14

Current status of 6 MV AMS Research at KIST

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Since The accelerator, which can raise the maximum acceleration voltage up to 6 MV, was completely set up in 2012 at Korea Institute of Science and Technology, Advanced Analysis Center (KIST AAC), various services and researches have been mainly carried out in applications of accelerator mass spectrometry. Currently, six elements (^{14}C, ^{10}Be, ^{26}Al, ^{36}Cl, ^{41}Ca and ^{129}I) can be analyzed by KIST 6 MV AMS, and we confirmed that the machine background of each isotope is sufficiently low.

Briefly, the applications, using KIST AMS, can be divided into four: 1) Age dating of various samples with radiocarbon, 2) Geological studies including paleoclimate restoration through ^{10}Be measurement accumulated in marine sediment and estimation of exposure age of rock using ^{10}Be and ^{26}Al measurement, 3) Environmental field research to build environmental changes related to the radiation pollution of the sea around the Korean Peninsula measuring ^{129}I and ^{36}Cl, and 4) Biomedical research.

Especially, AMS has been mainly used for biomedical application research since 2014. In order to prevent cross contamination of ^{14}C within age dating samples and biomedical samples which generally have high concentration of ^{14}C, biomedical samples pretreatment system have been established in different building. Professionals and equipments, which candirectly perform non-clinical testing, are prepared for various biological samples.

The researches based on microdosing and nanotracing technique had been mainly used in conducting biomedical application studies. Various researches were conducted in KIST AMS over the last 6 years: quantification of endogenous substances in body, evaluation of distribution of stem cell therapeutics, PK studies on high potency or highly variable drug, PK studies in the brain of candidates for Alzheimer disease treatment, quantification of drug metabolites (known), and quantification of biopharmaceuticals (antibodies or protein drug) in blood and tissues and brain distribution of CNS-related drugs that are difficult to measure due to BBB (Blood Brain Barrier).

Keywords: *AMS; Current status; Biomedical Applications*

New facility and status report II

O-15

Status of KOMAC-AMS

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The accelerator mass spectrometry (AMS) facility at Seoul NationalUniversity (SNU-AMS) [1,2], which was installed in 1998 and lateroperated, was relocated to KOMAC (Korea Mluti-purpose Accelerator Complex) located in Gyeongju, Korea. Commissioning is underway after the radiation safety permission have been obtained for the transferred 3-MV tandem accelerator (Tandetron, HVE). Much effort has been put into restarting, such as replacing outdated and damaged parts, and the basic operation of the accelerator has been verified. A carbon-14 AMS experiment is underway at 1.2 MV to verify the integrity of the device. In addition, we are conducting AMS target fabrication experiments using the newly prepared chemistry lab and sample preparation systems moved from Seoul National University. It also plans to promote MPS (Multi Purpose System) using two ion sources (SNICS and Duplasmatron) and switch magnets from Seoul National University. It will be used mainly for high energy ion beam irradiation and ion beam analysis.The long-term plan takes into account the AMS of other nuclides, eg actinides, which are needed to support the research of the KAERI (Korea Atomic Energy Research Institute). This report presents the current progress and future plans.

Acknowledgments: The authors would like to thank ProfessorJong-Chan Kim, a pioneer of AMS in Korea, for allowing the transfer of this system and for his helpful advice.

Keywords: *SNU-AMS; KOMAC-AMS; 3-MV Tandetron*

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New facility and status report II

O-16

AMS for New drug development support at KRICP in KIRAMS

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There are at least 130 AMS instruments distributed around the globe, with only a few dedicated to biomedical AMS. Biomedical AMS is used to support “tracer” studies where a “dose” enriched in ^{14}C is administered to a test subject (or laboratory animal) and the appearance and disappearance of the ^{14}C label monitored over time. The most well-known application of these tracers is for low ^{14}C mass balance Absorption Distribution Metabolism and Elimination or ADME studies, which are performed to define the biological fate and metabolism of the investigational drug. Other clinical applications include sub-therapeutic microdosing and absolute bioavailability (i.v. microdose) investigations that take advantage of the very limited animal testing required before human microdosing. The high sensitivity of AMS reduces the radioactive burden given to test subjects, making ^{14}C ADME studies more inclusive of all sub-populations (pediatrics, women, infirmed subjects). Given the potential of AMS for drug development, the Korean Government invested into a drug research center that has both AMS and Positron Emission Tomography as the core tools. These two radioactive tracer platforms are being applied to facilitate clinical (and preclinical) development of new drug candidates. This presentation will show the recent operational activity of the 0.5 MeV NEC AMS with gas accepting and graphite ion sources set up at Korean Institute for Radiological and Medical Research (KIRAMS). While validation was completed this year, the instrument was installed in and displayed stable ion beam currents since July 20th, 2018. Since its initial set-up, the instrument has analyzed biological samples and the palette of standards consisting of graphite blanks, C_3, C_8, Oxalic acid II and secondary standards of Ox12 and Ox100 prepared at Lawrence Livermore National Laboratory. The results post validation are presented as mean distribution plots with standard deviations. The instrument background ^{14}C/^{12}C ratio was less than 1e-15 and the verified dynamic range up to our currently highest standards of 101 Modern. The instrument post validation has supported two animal mass balance studies, both have an HPLC component. In summary, the KIRAMS AMS instrument is qualified and performing measurements for drug development in Korea. Optimization of the gas ion sources is the next stage in the AMS development. The facility is available to researchers from any Country in collaborative or fee-for-service models.

Keywords: *AMS; microdosing; ^{14}C; drug development*

New facility and status report Ⅲ

O-17

Status of the MALT-AMS system and analysis of environmental nuclides produced by the human nuclear activity

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MALT (Micro Analysis Laboratory, Tandem accelerator, The University of Tokyo) is a micro analysis laboratory using the ion beams generated by a tandem electrostatic accelerator. In the beam analysis techniques (Nuclear Reaction Analysis, Elastic Recoil Detection Analysis, Particle Induced X-ray Emission, etc), the seed of the ion beam is produced at the MC-SNICS negative ion source and accelerated to the proper energy by the 5UD Pelletron tandem accelerator made by NEC (National Electrostatics Corporation). Dedicated detection chambers for each analysis method are equipped at the end of beam lines. Special equipment for AMS (Accelerator Mass Spectrometry) is also installed including sequential injection system, high resolution mass analysis system, multi faraday cups, beam slits, and detectors. The maximum terminal voltage of the accelerator is 5.0 MV which enables multi nuclides AMS system, i.e., ^{10}Be, ^{14}C, ^{26}Al, ^{36}Cl and ^{129}I. Recently ^{236}U AMS system was also developed.

Among many applications of AMS, the environmental assessment related to human nuclear activities is essential. Several nuclides produced by the uranium-fission or neutron activation are important targets of AMS such as ^{14}C, ^{36}Cl, ^{129}I, and ^{236}U. Initiating with nuclear weapon testing anthropogenic nuclides began to be distributed in the earth environment and dynamically transferred by atmospheric and marine circulation still in today. Following the weapon testing, spent nuclear reprocessing plants had started to release nuclides into the environment. The historical aspect (time course variation of distribution) of nuclides diffusion is recorded in natural archives such as coral and ice core. Even in the same archives, different nuclides show different time course profiles reflecting their production/transportation characteristics. Currently we are analyzing coral and ice core by the collaboration with Philippine Nuclear Research Institute. From these analyses, we have gradually revealed the contrast of the isotope systems between of natural and of anthropogenic. We think this feature is the clearest definition of the "Anthropocene".

The advantageous of AMS arises from the combination of negative ion source and tandem accelerator. Recently many ideas not depending on the conventional technical construction. As such a technique, we focus on the Laser Photo Detachment. We have made a test-bench beam line for the interaction between negative ions and strong continuous laser.

Keywords: *^{129}I; ^{36}Cl; ^{236}U; ^{14}C; AMS; Laser Photo Detachment*

New facility and status report Ⅲ

O-18

Progress of Ultrasensitive Detection Techniques for the 6 MV multi-nuclide AMS System at the University of Tsukuba

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The 6 MV Pelletron tandem accelerator was designed and constructed for multi-nuclide AMS at the University of Tsukuba in 2016 [1]. It has two MC-SNICSs for the routine measurement. A five-electrode Δ E−E gas ionization detector is installed on the end station of the rare-particle detection system. We have developed ultrasensitive detection techniques for ^{10}Be, ^{14}C (graphite and CO_2), ^{26}Al, ^{36}Cl, ^{41}Ca, ^{90}Sr and ^{129}I in isotopic-ratio ranges from 10^{-9} to 10^{-16}. In the case of ^{36}Cl AMS, we developed the sulfur removal method to reduce ^{36}S contamination. AgCl samples are pressed into an AgBr backing in a large Cu sample cathode (6 mm diameter) in order to reduce ^{36}S contamination [2]. ^{36}Cl measurements are performed with a carbon foil (4.8 micro g cm^{-2}) and an 8+ charge state at 6.0 MV, with $^{36}Cl^{8+}$ being injected into the detector at 54.0 MeV. $^{36}Cl^{-}$ beam transmission is ~10%. The back ground of ^{36}Cl AMS has been improved to ^{36}Cl/Cl ~10^{-16} as the result of improved isobaric separation techniques. ^{41}Ca and ^{90}Sr were also detected by the 6 MV multi-nuclide AMS system for the first time in Japan. Especially, the background of ^{41}Ca AMS is reached to ^{41}Ca/Ca ~3×10^{-15}. The ion source can extract CaF_3^- beam currents up to 500 nA from CaF_2 materials. $^{41}Ca^{5+}$ with a total energy of 32.5 MeV is clearly measured by the ionization detector [3]. For ^{90}Sr-AMS, a $^{88}SrF_3^-$ beam can be extracted about 500 nA from a SrF_2 sample mixed with PbF_2 powder in the Al cathode from the MC-SNICS. $^{90}Zr^{8+}$ and $^{90}Sr^{8+}$ can be separated in two-dimensional spectrum by the gas-ionization detector with the total beam energy of 51.7 MeV. ^{90}Sr is detected in isotopic ratio ranges from 10^{-9} to 10^{-13}. ^{90}Sr AMS background is achieved ^{90}Sr/Sr ~6×10^{-13}.

^{36}Cl and ^{129}I were measured most frequently in order to investigate the radioactive contamination in rainwater and soil samples, caused by the Fukushima Daiichi Nuclear Power Plant accident. ^{10}Be and ^{36}Cl were also applied for the tracer of cosmic ray events and variations of solar activity. In this presentation, we will report on the status and progress of AMS techniques with the 6 MV tandem accelerator after 3 years operation.

Keywords: *Facility report; 6MV tandem; Multi-nuclide AMS*

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New facility and status report Ⅲ

O-19

Present status of JAEA-AMS-TONO in 2019

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JAEA-AMS-TONO has been in operation at the Tono Geoscience Center, Japan Atomic Energy Agency (JAEA) since 1998. It has applied to research into deep underground environments for R&D program related to the geological disposal of High-Level Radioactive Waste (HLW), and has also been used by researchers from universities and other institutes for studies of geoscience and environmental science under the common-use facility program of JAEA.

The AMS system is a versatile system based on a 5 MV tandem Pelletron type accelerator (National Electrostatics Corp., US). The system has been used for the routine measurement of carbon-14 (^{14}C), beryllium-10 (^{10}Be) and aluminium-26 (^{26}Al). In order to improve the efficiency of graphitization, the automated graphitization equipment (AGE 3, Ionplus, Switzerland) has been installed in 2017. In addition, the routine measurement of iodine-129 (^{129}I) has been started since fiscal year of 2019. Iodine isotope ratio (^{129}I/^{127}I) is a useful for estimation of sources and ages of deep groundwater such as fossil salt water, which is one of the indicators to assess geological disposal in coastal areas. The total measurement time and total number of samples exceeded 25,000 hours and 20,000, respectively.

Recently, the samples are increased for R&D program supporting development of technology for geological disposal of HLW. Therefore, a new AMS system (4103Bo-AMS, High Voltage Engineering, Europa B.V., Netherlands) will be introduced in fiscal year of 2020.

Keywords: *JAEA-AMS-TONO;* ^{14}*C;* ^{10}*Be;* ^{26}*Al;* ^{129}*I*

New facility and status report Ⅲ

O-20

A status report on a Single Stage Accelerator Mass Spectrometry at the Atmosphere and Ocean Research Institute, The University of Tokyo

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The NEC 250kV single-stage AMS (YS-AMS) was installed in March 2013 at the Laboratory for Accelerator Mass Spectrometry (LAMS), Atmosphere and Ocean Research Institute, The University of Tokyo. It is the first single-stage AMS system installed in Japan. The system is equipped with a 40 solid sample ion source (MC-SNICS-II), sequential injection system at low energy mass spectrometry side, open air 250kV high energy deck including helium gas stripper which acts as a molecular dissociation, analyzing magnet, electrostatic analyzer, sequential post-accelerator deflector, and final detector. Our routine ^{14}C measurements were started from August 2013, and have been keeping a high operational availability. During this period, the cumulated accelerator operation time is over 45,000 hours. We have performed more than 500 runs and acquired data more than 10,000 samples. The YS-AMS system is used for wide ranges of fields including earth science, paleoenvironmental science, marine science to fisheries science.

Keywords: *Single Stage AMS*

New facility and status report Ⅲ

O-21

Radiocarbon dating at The University of Tokyo

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The University of Tokyo established the Laboratory of Radiocarbon Dating as a university facility in 1970. Since 1985, AMS is applied for measuring ^{14}C in cooperation with MALT (Micro Analysis Laboratory, Tandem accelerator). In February 2014, a compact-AMS with 0.5 MV tandem accelerator (National Electrostatics Corp.) was installed at an exhibition hall in The University Museum. Since December 2014, our AMS system and preparation laboratory is rendering measurement service for many projects in The University of Tokyo.

The preparation lab provides several applications specialized for radiocarbon dating. The sample screenings using EA, FT-IR, and XRD are available for quality controls of bone, plant remains, and carbonates. Recently we have established a new target preparation protocol using an original semi-automated purification system, including an elemental analyzer (Vario ISOTOPE Select, Elementar Analyzersysteme GmbH) and a single-board micro-controller (Auduino Mega, Arduino.cc). The automated system, which has high flexibility regarding a sample volume and reduction methods takes 18 minutes for CO_2 purification typically. It made possible to measure about 1600 unknown samples in the last fiscal years.

Under the favor of this flexibility, we succeeded in the routine measurements of smaller samples up to 100 ugC, achieving a similar accuracy and precision of 1mgC regular target. In the case of micro samples less than 250 ugC, the target preparation requires specialized reaction vessels and reaction conditions, and the data corrections employ the sample size matching with standard and background. The minimum amount of less than 100 ugC is still experimental, but the ultra-micro scales are acceptable up to 30 ugC so far.

Because our lab is running as a service lab for the university members, we have substantially involved in some projects, not just for measurement. For example, the dating of human materials from prehistoric cemetery reveals some aspects of sociological stratification in the Jomon (Neolithic) period of Japan in addition to the change in dietary habits influenced by environmental fluctuations. Some more applications will be shown in this talk and discuss the direction of reasonable collaboration between AMS labs and researchers who interpret radiocarbon data.

Keywords: *Radiocarbon dating, archaeology; micro-scale analysis; geosciences*

New facility and status report III

O-22

Present status and application studies with HVE ^{14}C AMS system at Nagoya University (2017/18/19)

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A Model 4130-AMS by High Voltage Engineering dedicated to ^{14}C measurements was delivered to Nagoya University in 1996/97. Acceptance tests of its performance were completed in 1999, and a routine operation started in mid-2000. The number of targets measured was 330, 1430, 2077, 1003, 1,979, 1679, 1772, 1115, 1339, 866, 1300, 1701, 1449, 1634, 1351, 1741, 1156, 466, 900, 1345 and 622 in each year from 1999 to 2019, respectively, and total number of targets by the end of October 2019 is 27,254. We describe the maintenance processes of the AMS system as well as application studies in 2017-2019.

Major problems in 2017-2019 are; (1) two big sparks damaged the solid state RF driver for the high voltage generation. A RF-coil at the final part of the high-voltage power supply unit was broken; (2) a power supply unit for loading electrical current to adjust accurately the current for the recombinator magnet was in trouble. A resistor located at the end of the current supply circuit was burnt out; (3) a high-voltage spark damaged the electrical board used to control high voltage; (4) during the usual measurement, $^{12}C^{3+}$, $^{13}C^{3+}$ and $^{14}C^{3+}$ decreased gradually in about 10 minutes. The current of $^{13}C^{3+}$ decreased from 200nA to 5nA. We opened the accelerator tank and discovered that a timing belt to drive the power generator for supplying electric power to a terminal TMP was broken; (5) a high-voltage spark destroyed the IC-chip mounted on the control board of high voltage; (6) a Faraday cup in front of the ionization detector was in trouble. We checked the Faraday cup equipment and found out that the cup was disconnected from the pneumatic cylinder for controlling the cup position; (7) a computer system for controlling the AMS apparatus suspended sometimes, maybe by a heat problem of CPU; (8) a telemeter card in the ion source that controls the rotation of the wheel loaded with targets was in trouble. A capacitor to stabilize DC+5V from the power circuit on the card was broken; (9) a light guiding pathway in the ion source to monitor the target movement was disturbed by aluminum fragment dust. Owing to this interruption, correct exchange of the targets was impossible.

In application programs we dated many samples in cultural property, archeological, geological and carbon-cycling research fields from Japan as well as overseas. Some application results are discussed in this symposium.

Keywords: *AMS; radiocarbon; high-voltage-spark; beam-transmission; ion-source-cleaning; terminal-TMP*

AMS development

O-23

Research on Miniaturized AMS Measurement of ^{129}I

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Based on the Heavy ion tandem AMS (HIT-AMS) with a terminal voltage of 0.35MV which independently designed and constructed by China Institute of Atomic Energy, the ^{129}I measurement method has been carried out. The high efficiency, high precision and high sensitivity measurement method have been developed by systematic studies on ion transport, gas stripping, charge state selection, background elimination, etc. At present, the transmission efficiency of better than 50%, the measurement accuracy of 0.4%, and the measurement sensitivity of $^{129}I/^{127}I=1\times10^{-14}$ have been realized with the AMS system.

Keywords: *^{129}I; Heavy ion tandem AMS; high efficiency; high accuracy*

Technical development

O-24

Low Energy AMS for ^{10}Be and ^{26}Al at Tianjin University

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Beryllium-10 and Aluminum-26 have been widely used in many fields such as geological dating, galactic chemical evolution and solar system formation etc. The Accelerator Mass Spectrometry (AMS) is currently the ideal method for the measurement of ^{10}Be and ^{26}Al due to the longer half-life and lower naturally occurring content in real samples. In general, the measurement of both species requires a larger AMS system to suppress isobaric background interference of ^{10}B and ^{26}Mg. However, these analyses are very expensive due to the high complexity of AMS system. A smaller facility offers an economical cost due to its high efficiency and compact design. A compact ^{14}C low energy AMS system extended for ^{10}Be and ^{26}Al (XCAMS) was installed at Tianjin University in October 2017. For ^{10}Be AMS, the system was gradually smoothed and optimized based on a series of standard, blank and real samples measurement in the past two years. For ^{26}Al AMS, different batches of measurements are carried out separately with different materials of aluminum compounds, MgO, Ag and Nb, to study the Al- beam current and background interferences. Powder of Ag and Nb were added in different mass ratios to aluminum compounds and MgO, respectively. The experimental strategy, program and initial experimental results will be presented in this contribution.

Keywords: *^{10}Be; ^{26}Al; Low Energy AMS*

Heavy nuclides

O-25

Limits of sensitivity in Actinides AMS

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The VEGA AMS system at ANSTO, based on a 1MV tandem accelerator, was custom-designed to achieve the highest possible sensitivity for high mass isotopes [1]. It incorporates multiple medium-resolving power analysing elements: one magnetic element for the injected negative ions, followed by magnetic, electrostatic and second magnetic elements for positive ions after acceleration. This design, with mass and energy resolving powers in the range 500 to 1000, separates isotopes and suppresses backgrounds that may originate from a variety of ion species. The gas stripper in the high-voltage terminal is key both to system efficiency and to background suppression. Helium gas stripping is used, providing around 40% ion yield to the most abundant charge state (3+). The stripper pressure must be sufficient to break up all molecules while minimising the scattering angle of the ions as they undergo charge-changing collisions. Our recent work [1] has demonstrated that the VEGA sputter ion source (MC-SNICS) can achieve greater than 1% efficiency for production of plutonium oxide negative ions and so overall sensitivity at the level of a few hundred atoms in a sample is possible.

We are involved in a number of projects requiring high sensitivity and low backgrounds. Examples include (1) the detection of ^{244}Pu of extraterrestrial origin in deep oceanic ferromanganese crusts [2,3]; (2) radioecology of plutonium in the environment of former nuclear test sites [4,5]; (3) detection of nuclear signatures for nuclear safeguards and forensics; (4) use of Pu in global fallout as a chrono-marker in environmental studies [6]; (5) measurement of platinum-group-element isotope ratios in meteorites; (6) evaluation of the radio-purity of materials for use in dark matter searches.

Each of these projects presents their own particular challenges. In some cases, sensitivity is limited by background from scattered ions of species other than the one of interest. In other situations, cross-contamination between samples, in the sample prep lab or ion source, limits sensitivity. Other projects or previous uses of laboratories may leave residual contamination. For stable and very long-lived species, such as PGEs and major uranium isotopes, the ubiquity of those species at low levels in almost all materials sets limits to sensitivity.

Keywords: *Actinides, ^{244}Pu; uranium; detection limits*

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Technical development

O-26

Cryogenic trapping of CO_2 in the presence of other gases

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The preparation of radiocarbon targets for accelerator mass spectrometry (AMS) begins with the production of CO_2 gas from the sample carbon. The preparation steps may be broadly grouped as combustion, water stripping (desorption) and hydrolysis. These steps can introduce considerable quantities of other gases into the apparatus. For instance, at ANSTO we combust samples at 900°C in sealed tubes using CuO as a source of oxygen. For certain sample types considerable nitrogen can be evolved. Desorption of water involves the use of a carrier gas, often argon or helium, from which the sample CO_2 must be separated. We have observed that the cryogenic separation of CO_2 from these gas mixtures can take considerably longer than trapping an equivalent amount of pure CO_2. If sufficient time is not allowed for complete trapping of the CO_2 there is the potential for isotopic fractionation in the target.

We performed experiments to determine how the trapping time is affected by the gas composition and the degree of fractionation when inadequate time is allowed for complete CO_2 collection. These experiments were undertaken on our Micro Conventional Furnaces (MCF) [1]. We mixed CO_2 separately with H_2, He, CH_4, N_2 and O_2 at different concentrations. We then trapped the CO_2 by freezing it into the MCF cold finger at -150°C, recording the change of pressure with time. In order to be trapped, the CO_2 must diffuse through the apparatus to the cold finger. The presence of other gases hinders this process. We conclude that the trapping time is proportional to the square root of the molecular reduced-mass multiplied by the molecular collision cross-section of mixed gas. This result confirms that helium is the best choice of carrier gas to transfer CO_2 since it has a small mass and molecular cross-section and so slows the trapping of CO_2 the least. To study fractionation, we compared the measured pMC for samples that were prepared by partial trapping of pure CO_2 as well as CO_2 from a gas mixture. This experiment revealed that, in each case, the degree of fractionation was only determined by proportion of the CO_2 that was trapped. However, as much longer times are required to trap the same proportion of CO_2 in a gas mixture care must be taken to ensure sufficiently long trapping times are used to guarantee complete trapping.

Keywords: *Radiocarbon; CO_2; gas mixtures; separation; fractionation*

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Heavy nuclides

O-27

The sample preparation and the ICP-MS and AMS measurement of uranium at MALT

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The Micro Analysis Laboratory, Tandem accelerator (MALT) at The University of Tokyo is in process to the measurement of uranium AMS. Presently, MALT has implemented a sample preparation using the co-precipitation method and ^{236}U AMS with a gas ionization chamber detector. The Time-of-Flight (TOF) detection system is under construction for the further improvement of sensitivity. This paper focuses on the description of sample preparation of uranium, the analysis of uranium concentration using ICP-MS, and the measurement of ^{236}U/^{238}U atom ratio using AMS. Moreover, two design proposals of TOF system assembly at MALT will be introduced.

Keywords: *Uranium-236; Co-precipitation; Time-of-Flight; AMS; ICP-MS*

General AMS application

Keynote

O-28

Constraining the age of Aboriginal rock art using cosmogenic Be-10 and Al- 26 dating of rock shelter collapse in the Kimberley region, Australia

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The Kimberley region, northwest Australia, possesses an extensive and diverse collection of aboriginal rock art that potentially dates to more than 40,000 years ago. However, dating of such art using conventional techniques remains problematic. Here, we develop a new approach which makes use of the difference in production rates of in-situ ^{10}Be and ^{26}Al between intact rock walls and exposed surfaces of detached slabs from rock art shelters to constrain the age of Aboriginal rock-art. In the prevailing sandstone lithology of the Kimberley region, open cave-like rock shelters with cantilevered overhangs evolve by collapse of unstable, partially rectangular, blocks weakened typically along joint-lines and fractures. On release, those slabs which extend outside the rock face perimeter will experience a higher production rate of cosmogenic ^{10}Be and ^{26}Al than the adjacent rock which remains intact within the shelter.The dating of these freshly exposed slabs can help reconstruct rock-shelter formation and provide either maximum or minimum ages for the rock art within the shelter. The calculation of the timing of the event of slab release is strongly dependent on the local production rate, the new shielding of the slab surface and the post-production that continues on the ceiling sample at the matching point. The horizon, ceiling and slab shielding are estimated by modelling the distribution of neutron and muon trajectories in the irregular shaped rock-shelter and slab using 3D photogrammetric reconstruction from drone flights and a MATLAB code modified from G. Balco, 2014 to estimate attenuation distances and model the production rate at each sample. Five rock-art sites have been dated and results range from 9.8±1.9 ka to 180.8±22.3 ka. Within the context of regional landscape geomorphology, these rock shelter formation ages give new insights into the contrasting modes of landscape evolution in the Kimberley, and the importance of episodic escarpment retreat overprinted by passive basin-wide denudation which from numerous previous measurements are as low as 1-5 mm/ka (i.e. averaging timescales of ~400 kyr). A large number of similar sites in the region have been mapped and are potential candidates for this new approach which can constrain the controversial relative chronology of the various.

Keywords: *cosmogenic nuclides; rock art dating; Kimberely*

Carbon-14 age calibration and archaeological application

Invited

O-29

Expansion and demise of the Angkorian Khmer Empire

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The Angkorian Khmer Empire was the most influential political entity in Southeast Asia, flourishing from approximately the 9th to the 15th centuries CE (traditionally 802-1431). During its zenith between the 11th and 13th centuries, the Khmer Empire was expanded and covered most of the mainland Southeast Asia. Angkor, the capital district of this medieval Khmer Empire, is known as the largest low-density pre-industrial city on earth sustaining a population of up to 750,000 people. Despite its size, power and ostentatious wealth, 19th century European visitors found most of the Angkor region utterly abandoned. This paper presents an overview on the contribution of AMS radiocarbon dating to the study of expansion and demise of the medieval Khmer Empire, which we have carried out.

Our research included extensive chronological study of the iron production site of Tonle Bak using charred wood fragments and botanical remains collected in trenches, which were excavated at multiple locations across the site. Tonle Bak is situated south of the large Phnom Dek iron ore source in north-central Cambodia. Our hypothesis is that Angkor's expansion is directly related to increased access over Phnom Dek. We also employed sediments collected from Angkorian temple moats and water reservoirs, and their chronologies to explore issues of occupation at the study sites. Such information together with hydrological information obtained from a ^{14}C-dated stalagmite in southern lowland Cambodia provided important insights into the decline of the ancient Angkorian Empire.

Keywords: *Radiocarbon; Angkor; Cambodia; archaeology; iron smelting*

General AMS application

O-30

Radiocarbon dating Ancient Loulan City

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The discovery of the ancient city of Loulan in Xinjiang, China, at the beginning of the twentieth century was of great significance for understanding the evolution of culture and civilization in Inner Asia. However, due to the lack of systematic chronological studies, the history of this ancient city remain unclear, particularly the date of its construction and abandonment. Here, we present the results of the first systematic radiocarbon dating carried out on artifacts from ancient Loulan. Our results show that human activity began as early as 350 cal B.C., flourished during the interval from the first to 4th century A.D., and completely disappeared around 600 A.D. Most of the buildings in the city were constructed during the Eastern Han dynasty rather than in Wei/Jin dynasty, as previously indicated by excavated documents and letters. The development and flourishing of Loulan coincided with the interval of high ice accumulation and meltwater supply from surrounding mountains. The city began to decline and was finally abandoned following an abrupt decrease in ice accumulation and meltwater supply (Yao *et al*., 1996; Lauterbach *et al*., 2014), suggesting that natural climate change was the major factor responsible for the abandonment of Loulan city.

Keywords: *Loulan City; Radiocarbon dating; climate change*

Space and earth environmental science III

Keynote

O-31

A long time-scale record of East Asian monsoon rainfall from Chinese loess ^{10}Be

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The East Asian monsoon is an essential element for the Asia-Pacific hydrological circulation system. Therefore, great efforts have been made in the reconstruction of monsoonal paleorainfall by using different geological records to understand the East Asian monsoon development. However, the differences between these records have led to debates on the mechanisms that drive the East Asian monsoon intensity. Taking aiming at this question, in 2007, we firstly quantitatively reconstructed an 80-ka paleorainfall record by using the cosmogenic ^{10}Be flux and proposed that the Asian Monsoon was closely related with the summer solar insolation differential between the Northern and Southern Hemispheres. Based on this work, in early 2019, we reworked in the field of Baoji loess-paleosol sequences, to quantitatively reconstruct a much longer time-scale record of paleorainfall from loess ^{10}Be. This paleorainfall record shows clear orbital precession frequencies, and meanwhile is highly correlated with global ice-volume variations. The results further verify that the East Asian monsoon is governed by the summer solar insolation differential between the Northern and Southern Hemispheres, which can also influence global ice volume via monsoon dynamics. This view challenges the conventional Milankovitch theory to some extent.

Keywords: *Asian monsoon; Loess ^{10}Be; Paleorainfall*

Space and earth environmental science III

O-32

A high-resolution radiocarbon dating sand-loess sequence at Yulin, north-central China and East Asian winter monsoon variations

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Eolian deposits in the sand-loess transition zone in Northern China are good terrestrial archives to investigate past climate changes and eolian dust activities. However, lack of accurate and high-resolution chronologies hindering our ability to interpret climate proxy. In this study, based on 44 radiocarbon ages and compared with 10 pairs of luminescence dating ages, we establish a millennial to multi-centennial resolution chronology of loess-sand record at Yulin, north-central China in order to reconstruct East Asian winter monsoon variations. The aeolian sand and dust accumulation rate is a direct proxy indicator of the East Asian winter monsoon intensity and is controlled by both vegetation and wind strength. The increased sediment accumulation rate corresponded to strengthened winter monsoon events. Based on the independent timescale, we find up to 13 winter monsoon strengthened events over the past 14 ka, providing a millennial to multi-centennial record of East Asian monsoon variations. These winter monsoon events are dominated by the cold events in high-latitude, presenting new evidence that high-latitude forced the rapid winter monsoon change during Holocene.

Keywords: *loess; radiocarbon dating; OSL; Asian monsoon*

Space and earth environmental science III

O-33

Determining diurnal fossil fuel CO_2 and biological CO_2 by $\Delta^{14}CO_2$ observation on certain summer and winter days at Chinese background sites

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Diurnal atmospheric $\Delta^{14}CO_2$ was measured on two consecutive days in summer and winter, 2016 at Shangdianzi, Lin'an and Luhuitou regional background sites, and at Waliguan global background site in China. The objectives of this study were to determine diurnal fossil fuel CO_2 (CO_2ff) and biological CO_2 (CO_2bio) concentrations, and then to ascertain the factors influencing them. Evident CO_2ff inputs (0 – 33.0±1.4 ppm) were found, with some small morning and afternoon rush hour signals. Particularly, the trajectory transitions of long-range transport of air masses influenced CO_2ff variations. Diurnal CO_2bio showed violent variations (-20.9–113.3 ppm), with high values at night and low or negative values during the daytime. Some negative CO_2bio during 12:00−18:00 even resulted in atmospheric CO_2 drawdown over background level. These results might help to understand the roles of fossil fuel sources and biological sources on atmospheric CO_2 diurnal variations at Chinese background sites.

Keywords: *CO_2; biological and fossil fuel sources; ^{14}C*

Space and earth environmental science III

O-34

Chemometric Analysis of ^{14}C and Fourier Transform Infrared Spectra to improve the chronology of Lake Biwa sediment core

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Lacustrine sediment cores contain high-resolution records of past environmental changes. However, the interpretation of the records has been often hampered by low dating resolution. High-resolution chronologies of sediment cores are crucial for elucidating the timing of short-term climatic events in the past and for comparing climatic changes at local, regional and global scales.

Sediment core chronologies covering the past 50 ka are mostly based on the radiocarbon dates of which are made on terrestrial plant remains such as wood fragments, seeds and leaves. In most case, a proper number of terrestrial plants are not often available. Investigators have hopeless dated bulk sediment samples and chemically separated fractions such as the humic acid (alkali-soluble) and humin (alkali insoluble) fractions of bulk sediment. However ^{14}C dates of these samples have provided invaluable information which is not simply for chronology purposes.

Radiocarbon age of bulk sediment can be influenced by several factors, for example such as 1) reservoir effect of aquatic organic matters by dissolved carbon originating from ^{14}C-dead calcareous rocks or decomposed organic matters in sediments, and 2) incorporation of pre-aged organic matters from the drainage basin. In freshwater lakes, the latter may cause more serious problem to obtain deposition age. Some investigators have adjusted the radiocarbon ages of bulk sediments by comparison between the radiocarbon ages of bulk sediments and terrestrial plant remains collected from the same stratigraphic horizons and by the N/C ratio-based correction. The combination of radiocarbon dates from terrestrial plant remains and bulk sediments successfully improved the resolution of sediment core chronologies, but they were in limited cases. An alternative approach for adjusting radiocarbon ages from bulk sediments to the deposition ages. Physical, chemical and even sediment properties of lake sediments have been investigated by means of the chemometric analysis of Fourier transform infrared (FTIR) spectra. The chemometric analyses such as principal component regression (PCR) and partial least squares regression (PLSR) can be used to reveal masked information from the complicate FTIR spectra without the need for a priori assignments. We have examined a FTIR spectra-based ajustments of radiocarbon age offset of bulk sediments to quantify the contribution of aged organic matters on lake sediments which relate to radiocarbon age offset of bulk sediments. This approach applied to a Lake Biwa sediment core which appropriate materials for radiocarbon dating was not generally available. We introduce the unique approach and discuss the effectiveness and limitation about it.

Keywords: *Age-depth model; TOC; FTIR; Chemometrics*

Abstracts

Poster presentation

New facility and status report

P-01

A new compact radiocarbon AMS (MIni CArbon DAting System) recently installed at Nanjing University

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A compact Accelerator Mass Spectrometer system (MIni CArbon DAting System) accompanied by a Stable Isotope Ratio Mass Spectrometer (MAT253 plus) has been installed at School of geography and ocean science, Nanjing University in December, 2018. The NJU-MICADAS is equipped with a 200 kV tandem accelerator employing helium stripping, which gives a transmission up to 47%, a cesium sputter ion source capable of accepting both solid and gas cathodes, and a state of the art gas ionization detector. Accuracy of radiocarbon measurement and other related parameters of MICADAS were reported by Hans-Arno Synal in 2007 [1]. The NJU-MICADAS has also reached or better than these parameters and has been tested and verified for acceptance by peer experts on installation site. In this symposium, measurement of different samples and running status of our AMS in the past year will be reported. Radiocarbon dating results of some previously dated samples from other AMS laboratory or samples of generally known age will also be presented.

Keywords: *Nanjing University; MICADAS; running status*

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New facility and status report

P-02

Research and performance with YU-AMS system

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In 2009, Yamagata University (YU) installed an AMS (YU-AMS) system in Kaminoyama Research Institute. This AMS system is based on a 0.5 MV Pelletron accelerator (CAMS) developed by National Electrostatics Corporation. The system consists of a multicathode negative ion source generated by cesium sputtering (MC-SNICS) for converting the sample to negative carbon ions, a 45° electrostatic spherical analyzer (ESA), a 90° bending magnet with a biased chamber for sequential injection, an acceleration tube (NEC 1.5SDH-1), a 90° analyzing magnet, offset Faraday cups for measuring ^{12}C and ^{13}C beam currents, a 90° ESA, and a solid-state detector (SSD) for counting the ^{14}C beams. This AMS system is the first AMS system installed in a university in northern Japan (Tohoku–Hokkaido region). In March 2014, a second automated graphitization line and a second ion source on the AMS system were installed. The automated graphitization line consists of an elemental analyzer (EA, Vario MICRO cube, Elementar), stable isotope ratio mass spectrometer (IRMS, Isoprime), and a glass vacuum line. The automated graphitization line can be used to treat more than 2,400 samples per year. The EA in the automated system is a useful tool for combusting and producing CO_2 gas from samples. However, this method is not appropriate for shell and coral samples, because the EA combusts not only calcium carbonate ($CaCO_3$) but any organic carbon incorporated in the sample. Thus, a phosphoric acid treatment system was installed in the glass vacuum line for shell and coral sample treatments. In 2018, approximately 3,000 samples are measured using the YU-AMS system. The most commonly measured samples were wood. The second and third most commonly measured samples were charcoal and soil, respectively, which were mainly extracted from historical remains. In this conference, we report the status of the YU-AMS system.

Keywords: *YU-AMS; Automated graphitization line; radiocarbon dating*

New facility and status report

P-03

Status report of the compact AMS facility at GIG, CAS

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The NEC 0.5 MV compact accelerator mass spectrometer was installed in April, 2014 at Guangzhou Institute of Geochemistry, Chinese Academy of Sciences. Routine ^{14}C measurement was performed since September, 2015. Up to now, more than 5000 samples include standard and background samples have been measured in our AMS system. Here we present the performance of GIG-CAMS. 100-150 μA beam current can be extracted from ion source and kept about 45 minutes with the sample size of 0.8-1 mg graphite. 80-110 μA $^{12}C^-$, 25-35 μA $^{12}C^+$ and 300-400 nA $^{13}C^+$ can be regularly obtained. More than 600,000 ^{14}C counts can be detected from an regular size OXII graphite sample (1 mg) with 12-16 runs. The background of processed graphite sample are about 1.3 pMC for 10 μg graphite and 0.16 pMC for 1 mg graphite, respectively. The uncertainty of routine measurement is better than 0.5% for modern samples.

Keywords: *AMS; radiocarbon*

New facility and status report

P-04

MALT Accelerator Report 2019

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MALT (Micro Analysis Laboratory, Tandem accelerator, the University of Tokyo), currently belonging to the University Museum, has been in operation as a research and educational facility with a tandem accelerator since 1994. The accelerator of MALT is a 5UD Pelletron tandem van de Graaf (produced by National Electrostatics Corporation, USA) and max terminal voltage is 5MV. In addition to AMS, NRA (Nuclear Reaction Analysis), ERDA (Elastic Recoiled Detection Analysis) and PIXE (Particle induced X-ray Emissions) systems are also available, and about two third of the total accelerator operating time is usually spent for AMS measurement. The number of ongoing research projects is around 30, and over 20 projects of them are using AMS system.

Although we have had many small troubles due to the deterioration of apparatus, the annual operating time has been maintained around 5,000 hours since 2003. Also recently, not only small troubles but some serious ones have occurred frequently. In 2018 alone, critical malfunctions occurred in a circulating water chiller system and a power supply for analyzing magnet, and moreover a compressor of insulation gas recovery unit broke into pieces owing to the overuse and the defect of maintenance. After that, in this July, power supplies of electrostatic quadrupole lens inside the accelerator tank were broken down. Because we couldn't open the tank and repair them, we modified the beam line under the tank to install extra magnetic quadrupole lens.

In fiscal 2019, from April to October, the accelerator operating time has reached almost 3,600 hours. Going on at this rate, the annual time will reach to over 6,000 hours for this year. However, troubles around accelerator are gradually increasing and the compressor has not been repaired yet. In order to maintain and improve the performance and availability of MALT, it will get more and more important to secure a sufficient budget and spare apparatus to repair a defective part immediately, and to renew old apparatus before it gets out of order.

Keywords: *Tandem accelerator; Pelletron*

New facility and status report

P-05

A New Accelerator Mass Spectrometry Facility in Qingdao National Laboratory for Marine Science and Technology, China

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A new accelerator mass spectrometry (AMS) facility has been established in the Center for Isotope Geochemistry and Geochronology at Qingdao National Laboratory for Marine Science and Technology (QNLM) in Qingdao, China. The AMS system is a 0.5 MV Model 1.5SDH-1 pelletron accelerator, manufactured by the National Electrostatics Corporation (NEC) in USA. The AMS system was installed and passed the acceptance tests in November 2018. It has the capability for high precision measurements of ^{14}C, ^{26}Al and ^{10}Be. The AMS facility is also supported by a laboratory of stable isotope ratio mass spectrometer (IRMS) and a modern sample preparation laboratory with an automated graphitization system of AGE3, manufactured by Ionplus of Switzerland. The Center for Isotope Geochemistry and Geochronology at QNLM, with additional major instruments such as TIMS and MC-ICP-MS, is the first such integrated facility in China and is dedicated to provide quality services for isotope and radiocarbon dating measurements for marine science and environmental studies in the years to come.

Keywords: *AMS facility; Isotope; Geochronology; National Laboratory*

New facility and status report

P-06

Status of the QNLM-AMS facility and the process blank assessment of small sized samples for ^{14}C analysis

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The QNLM-AMS facility is based on the National Electrostatics Corporation 500 kV 1.5SDH-1 Compact Accelerator Mass Spectrometer for ^{14}C, ^{10}Be, and ^{26}Al (NEC XCAMS). The QNLM-AMS facility is additionally equipped with an Automated Graphitization Equipment (AGE3) coupled with an Elemental Analyzer (EA) and a Carbonate Handling System (CHS$_2$), which simplify the graphitization protocol for ^{14}C measurement.

At the initial operation stage, the QNLM-AMS provides a precision of 0.83% for ^{10}Be measurement performed with three BeO samples with a known ^{10}Be/^{9}Be ratio of 2.5×10^{-12}, and a background value of 4.2×10^{-15} with three dead BeO samples. For ^{26}Al analysis, a precision of 0.13% has been achieved with four Al_2O_3 samples with a known ratio of 5.0×10^{-11}. A background value of 1.4×10^{-14} has been obtained with four dead Al_2O_3 samples. Up to now, the QNLM-AMS mainly runs for ^{14}C analysis. The precision of ^{14}C/^{12}C for the Oxalic Acid II (OXII) is better than 0.3%, and the background ^{14}C/^{12}C ratios of coal and carbonate (IAEA-C1) standard are less than 3×10^{-15} and 2×10^{-15}, respectively. With regard to the pre-treatment of samples for ^{14}C measurement, different preparation protocols have been investigated and the procedural blanks have been assessed. Here, we present our initial results of process blanks during preparation of different samples types.

Keywords: *new facility; blank assessment*

New facility and status report

P-07

Current status of the compact-AMS system at Paleo Labo Co., Ltd.

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Paleo Labo Co. Ltd., a private company in Japan installed a compact ^{14}C-AMS system in November 2004. The system was designated as CAMS-500 (NEC, U.S.A.) and is based on a 500 kV Pelletron accelerator. It was designed very compact so that the beam tuning components are simple with only one Einzel lens, three steerers, one ESA (electrostatic analyzer) and two analyzing magnets. In order to estimate every measurement, we simultaneously measure the standard samples of IAEA C1 and C7. The results of standard samples measured during this one year. Average and standard deviation (1 sigma) of pMC value of each standard sample were 0.153 ±0.045 pMC (consensus value: 0.00±0.02 pMC), 49.53±0.21 pMC (consensus value: 49.54±0.13 pMC). These results also show very stable and high precision measurements. Since its installation, a total of 47,907 samples (35,398 unknown samples and 12,509 standard and test samples) have been measured until the end of September 2019. We report the current status of our AMS system.

Keywords: *^{14}C-AMS; Compact AMS*

New facility and status report

P-08

Performance of a newly installed MICADAS at the Ocean University of China

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An automatic graphitization system (AGE 3) and gas ion source interface (GIS) with a compact mini carbon dating system (MICADAS) dedicated to measuring ^{14}C content in small samples were installed at the Ocean University of China in May of 2019. Using the AGE 3, we have made a total of more than 300 targets from OXII standards, backgrounds, known-age samples and peat plants during the past few months. The mean Fm value of OXII measurements on 1 mg size of carbon is 1.3407±0.0031 (n = 45). The average Fm value of ^{14}C-free phthalic anhydride (PhA) is 0.0020±0.0016 (n = 38) which yields a total background including combustion, graphitization and machine value equivalent to at least 50000 ^{14}C yr BP. Measurements of IAEA reference materials with various ^{14}C contents showed good agreements with the consensus values. Performance of the gas ion source coupled with the GIS was tested with two CO_2 introduction units: the elemental analyzer and the breakseal cracker. Those tests show that 10~100 μgC of CO_2 can produce a ^{12}C (low energy) ion beam on the order of 10~15 μA during counting time ranging from 4 to 15 minutes. The precision of the gas measurements on modern samples of about 100 μgC is around 8‰, and the blank is older than 40000 ^{14}C yr BP.

Keywords: *Radiocarbon; Gas ion source; Graphite*

New facility and status report

P-09

OUC-CAMS：An introduction of the MICADAS installed at the Ocean University of China

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A compact mini carbon dating system (MICADAS) dedicated to measuring the ^{14}C content in small samples was installed at the Ocean University of China in May of 2019. The installation also included an automated graphitization equipment (AGE), a gas ion source interface system (GIS) and a carbonate handling system (CHS 2). The MICADAS operates at around 200 kV with carbon ion stripping in helium leading to a transmission efficiency of about 47%. The hybrid ion source works with both graphite target and CO_2 gas. The versatile gas interface system (GIS) ensures steady gas transfer from two different inlets: a cracker for CO_2 in glass ampoules and an elemental analyzer for combusting organic matter to CO_2. High-precision δ^{13}C results are conveniently obtained by an IRMS through a split of CO_2 from the GIS. The MICADAS coupled with the GIS could measure CO_2 gas from ~10 to 100 μgC and measure graphite targets from 0.5 to 1 mgC produced by the AGE. The ^{12}C-HE beam current of a regular OXII target is above 35 μA under Cs temperature of 150°C, with ^{14}C counts >500,000 during 25 minutes measurement. The capability of running ultra-small CO_2 gas samples by MICADAS opens up the door to various applications of compound specific radiocarbon analysis (CSRA).

Keywords: *Radiocarbon; Gas ion source; Graphite; Carbonates*

New facility and status report

P-10

AMS program in Tianjin University

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A 0.5MV tandem accelerator mass spectrometry (AMS) system for ^{10}Be, ^{14}C and ^{26}Al, which was manufactured by National Electrostatics Corp. (NEC), has been installed in October 2017 at ISESS of Tianjin University, China (TJU-AMS). Its design follows that of previously commissioned NEC compact ^{14}C-only AMS systems. The difference from that design is an extension of the rare-isotope section with a 45° magnet and a two-anode gas-ionisation detector, to provide additional filtering for ^{10}Be. Such rare-isotope beamline extension has not affected precision of ^{14}C measurement.

Based on the repeated measurements of a series of standard and blank samples, the precisions for ^{14}C/^{12}C, ^{10}Be/^{9}Be and ^{26}Al/^{27}Al can generally reach 0.3%, 3% and 3%, respectively. The detection limit of the system has been achieved to be 4×10^{-16} for ^{14}C/^{12}C, 2×10^{-15} for ^{10}Be/^{9}Be and 6×10^{-15} for ^{26}Al/^{27}Al. In addition, the precision of the ^{13}C/^{12}C ratio can be routinely <0.3% in the conditions of wide range of the ^{12}C- beam currents. This advantage allows us to use the on-line AMS-measured ^{13}C/^{12}C for correction of carbon isotope fractionation.

The TJU-AMS system has opened new research fields in Tianjin University. For example, ^{14}C has been widely used as a powerful dating method and tracer/proxy for studies in archaeology, Earth science and environmental science; In-situ ^{10}Be and ^{26}Al have been applied to date the exposure age and burial age, and to quantify the erosion rates in different spatial scales; (3) meteoric ^{10}Be has been combined with in-situ ^{10}Be for studies of the catchment erosion.

In this presentation, a detailed description of configuration and routine performance conditions of the TJU-AMS system will be given. Some case applications of cosmogenic radionuclides will be also reported.

Keywords: *AMS; ^{14}C; ^{10}Be; ^{26}Al; Tianjin University*

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New facility and status report

P-11

A new capability for ^{41}Ca analysis using CaF_3^- at the Xi’an-AMS

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The analysis of ^{41}Ca can be quantified by measuring the ratio ^{41}Ca/^{40}Ca, where Ca is the total calcium. At present, ratios of ^{41}Ca/^{40}Ca ≤ 10^{-11} can only be measured by accelerator mass spectrometry (AMS). The sensitivity is mainly limited by the interference of the isobar ^{41}K. With compact AMS (≤1 MV), abundance sensitivities of 10^{-11} to 10^{-12} have been demonstrated, but this may necessitate the measurement of ^{39}K to correct for the ^{41}K background. With a 3 MV AMS, the dE/dx method can still be used to partially separate ^{41}Ca from ^{41}K. In this work, a new capability for ^{41}Ca analysis has been tested at the Xi’an-AMS. Ca^{4+} was chosen to achieve a balanced performance between ^{41}Ca/^{41}K separation and transmission efficiency. A ^{41}Ca/^{40}Ca background level of near 10^{-13} was achieved without the need for ^{41}K correction. This new analytical capability at our facility was then applied to ^{41}Ca tracer samples from our studies on the “White Jade” land snail shells, in which ^{41}Ca was used as a tracer for studying the absorption rate of calcium.

Keywords: *^{41}Ca; Xi’an-AMS; Calcium absorption rate*

Technical development

P-12

A Study of Surface Stripper for the AMS System with a Footprint below 2 m × 2 m

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State of the art technology for downsizing AMS systems has reached a stage in the development of ^{14}C-AMS systems with a footprint below 2 m × 2 m (the energy range around 45 keV without an accelerator) [1]. In such a small system, higher background would be a major problem, which is mainly due to poor vacuum conditions originated from a gas stripper used to destroy interference molecules such as $^{12}CH_2$, ^{13}CH. As the system is getting more compact, the position of the gas stripper becomes closer to a magnetic filter, reducing space for installing an adequate pump to maintain better vacuum inside the magnetic filter. The residual gas atoms inside the magnetic filter act targets for collisions, which would be a source of the background.

Based on ion–surface interactions, a novel stripper technique, which would be termed "surface stripper", was proposed as a gas free stripper by Matsubara *et al.* [2]. Under grazing angle incidence of ions on a single crystal surface, the ions are specularly reflected by a repulsive planer potential of the first atomic plane. During the reflection, the ions interact with surface electrons, which may result in charge transfer and dissociation of those interference molecules. In addition, the specular reflection not only ensures suppression of beam loss caused by large angle scattering, but also is of advantage to avoid damage to the crystal surface.

As a preliminary step of a feasibility study on this novel stripper technique, a numerical study has been started with the aim to reveal the charge transfer and dissociation efficiencies of the technique. The trajectory of ^{14}C specularly reflected from a crystal surface was calculated. In this calculation, we employed the crystal surface of SnTe(001) that has been commonly used in the study of ion–surface interactions. It was found that in the case of incident energy of 45 keV and incident angle of 1.5° with respect to the surface, the electron density integrated along the trajectory can be equivalent to that in the He-gas stripper of 0.4 $\mu g/cm^2$ that is sufficient for destroying interference molecules. This suggests that the present technique can provide sufficient molecular suppression comparable to the gas stripper.

Keywords: *Downsized AMS (DAMS); Gas-Free; Surface Stripper*

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Technical development

P-13

Ion Source development at the compact AMS at PKU

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The National Electrostatics (NEC) 40-sample MC-SNICS ion source at the PKUAMS laboratory was put into operation in September 2004. Following the idea of John Southon at UCI and with the help of NEC, we changed the original conical ionizers to spherical ionizers in 2008, which improve the focusing of Cs beam obviously. Recently, based on the beam optics, we have further replaced the extractor and pre-acceleration assemblies. In this presentation, we introduce the new structure with modified ion source and the improved performance of the ^{14}C measurements.

Keywords: *Ion source; extractor; Spherical ionizer*

Technical development

P-14

A performance report of the automatic pressing machine developed at the Atmosphere and Ocean Research Institute, The University of Tokyo

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A single-stage AMS (SSAMS) is equipped with open air 250 kV high energy deck without high voltage parts with pellet-chain and accelerator tank. Thus the SSAMS can be operated in much more stable fashion compared to larger machine. Improvement of the stability for ion beam generated at the ion source is therefore able to contribute improvement of radiocarbon measurements in particular achieving uniform conditions of target graphite at the ion source[1]. The issues were raised since graphites were pressed manually and placed into the MC-SNICS. However fluctuations have been observed during the various measurements. Hence an automated sample graphite pressing system was developed at Atmosphere and Ocean Research Institute, The University of Tokyo in 2017. In this presentation, we will report the details of the system as well as the results obtained from SSAMS for those samples prepared by new apparatus.

Keywords: *single-stage AMS; Radiocarbon dating; Automatic pressing*

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Technical development

P-15

Development of an automated system for conventional ABA treatment

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KIGAM AMS laboratory developed an automated chemical treatment system named “Aba Chembot” for a conventional ABA(acid-base-acid) method for woods and charcoals which are the most frequently requested samples for radiocarbon age dating. The purpose of developing the Aba Chembot is as follows. First of all, the ABA treatment usually takes between 300 and 360 min to process 12 samples. And we have measured over 32,000 samples for a past decade, and 25% of them were treated by ABA treatment. It attempts to reduce processing time through the Aba Chembot to increase the number of samples that can be processed per day. Secondly, it is to eliminate the error of the experiment caused by human error because it is difficult to perform experiments accurately and consistently.

The Aba Chembot processes 12 samples at a time and consists of five parts: acid, base solutions and distilled water supplying units, a drainage system for solutions, heating system, a stirrer for shaking during reaction and a system control unit. This system is connected to a computer and operated through program developed by our lab. The samples is treated by acid solution at 80°C for 30 minutes and rinsed by distilled water three times and the same process conducted by base solution and acid solution again. The whole process is operated automatically and it takes only 120 minutes, so the 36 samples can be treated in a day. The wood background material samples treated by Aba Chembot and the average $^{14}C/^{12}C$ ratios of 48 samples marked 1.8×10^{-15}.

Keywords: *automated system; radiocarbon; ABA treatment*

Technical development

P-16

New procedure of CO_2 extraction for radiocarbon analysis of DIC in water samples at Nagoya University and Geological Survey of Japan

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For radiocarbon analysis of DIC in water samples, carbon extraction is required. A bubbling procedure known as the WOCE (World Ocean Circulation Experiment) method is the most widely used for water preparation, but it is difficult to be adapted to various water samples, such as groundwater and hot-spring water. Therefore, we employed other procedures, that is, carbonate precipitation (Nagoya Univ.) and headspace gas purge (Geological Survey of Japan). The reasonable ^{14}C results have been obtained using these procedures, while they have many minor problems. Hence, we established new procedure of CO_2 extraction from water at both laboratories, and we will present it on the EA-AMS symposium.

New procedure was basically improved from the headspace gas purge method that had been employed at the Geological Survey of Japan. The problematic points for the headspace gas purge method are as follows: (1) a large amount of water enters in vacuum system, (2) helium carrier gas is needed, and (3) water amount extracted at once is less than 50 mL owing to limitation of vial size (100 mL). To solve these problems, glass vial was changed to flask (100-500 mL) attached by septum joint with ultra-torr fitting. CO_2 extracted from water samples to headspace of flask was introduced without using the carrier gas by expanding to vacuum line from extraction flask due to pressure gradient. We obtained the high CO_2 yield to be ca. 97-98% at the both laboratories. The background of carbon contamination was negligible. Time required for CO_2 extraction has been shortened to 30 minutes for one water sample by the new procedure. Because this procedure can suppress the water intrusion to the vacuum system, the evacuation between treatments became shorter.

Keywords: *Radiocarbon; DIC; CO_2 extraction; new procedure*

Space and earth environmental science

P-17

Halogen isotopes analysis in Greenland SE dome ice core

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^{36}Cl (Half life: 3.01×10^{5} yr) is long lived radio isotope which is produced by the neutron activation of ^{35}Cl. In 1950's and 1960's, vast amount of ^{36}Cl was produced due to a number of atmospheric nuclear bomb testing. In contrast to ^{129}I (Half life: 1.57×10^{7} yr) , ^{36}Cl is merely released from spent fuel reprocessing plant. The time course profile of ^{36}Cl recorded in ice core will be totally different from ^{129}I. The objective of this study is to clarify the contrast of time course variation of ^{36}Cl and ^{129}I recorded in the same ice core.

The ice core sample used in this work was taken from SE dome located in the southeast Greenland (7.18° N, 36.37° W, 3170 m a.s.l.) in 2015 [1]. It covers from year 2015 to 1955 with high time resolution [2]. Major elemental concentration and oxygen isotope data were already analyzed in details [3]. We obtained samples corresponding from 2007 to 1956. We divided into two for each numbering sample, one is for ^{129}I analysis and the other for ^{36}Cl. ^{129}I profile from 1976 to 1977 was already analyzed by one of the authors [4].

This study analyzed ^{36}Cl from 1965 to 1956 just covering the "bomb peak". ^{36}Cl profile for Greenland ice core was previously once analyzed for Dye 3 station [5]. However it is first time that ^{36}Cl and ^{129}I are analyzed from the same ice core. We found the bomb peak of ^{36}Cl but there is a little discrepancy with the ^{129}I peak timing. This should be due to the difference of transportation mechanism.

In this work, complete data set of stable iodine concentration of this core was obtained. Since the concentration of iodine was quite low as the order of 0.01ppb, all samples were once oxidized to be iodate and then measured by ICP-MS after properly diluted. One prominent peak was found and this is coincides to the Sodium peak of the ice core. The time course variation shows the gradually increase towards present which is consistent with the other studies [6,7].

Keywords: *^{36}Cl; ^{129}I; Accelerator Mass Spectrometry; Greenland ice core; Nuclear weapons testing; iodine concentration*

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Space and earth environmental science

P-18

Interpreting ^{10}Be records in sediments with a chemometric analysis of optical properties

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The interpretation of ^{10}Be records from lake sediment cores is problematic because the ^{10}Be source changes with time. The secular ^{10}Be variations from lake sediment cores can be constrained by the contribution of the different ^{10}Be source which is likely influenced by climatic and environmental changes on local, regional and global scale. To interpret ^{10}Be records in lake sediments in detail, it is crucial to clarify the time-varying change in the contribution of ^{10}Be source in sediments supplied from different pathways such as eolian deposit and loading from the catchment area. In this study, we introduce a unique approach to infer the time-varying change in contribution of different sediment source using a chemometric analysis of Fourier transform infrared spectrometer spectrum. We applied this approach to a ~50 ka ^{10}Be record from a well-dated Lake Biwa sediment core. We discuss the potential for interpreting ^{10}Be in lake sediment cores in relation to the climatic and environmental changes.

Keywords: *^{10}Be; lake sediment; chemometric analysis; FTIR*

Space and earth environmental science

P-19

Tracing study and source analysis of atmospheric fossil fuel CO_2 by radiocarbon and air pollutants in Xi’an, China

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AMS-^{14}C is an effective way to quantify CO_2 emitted by fossil fuel consumption in cities. We used self-designed active absorption system with a molecular sieve to continuously collect atmospheric CO_2 samples from January 2016 to January 2017 in Xi’an, China. During the study period, the atmospheric $\Delta^{14}C$ in Xi’an fluctuated significantly, ranging from (-1.00±2.84) ‰ to (-187.25±3.62) ‰. The concentrations of CO_2ff also showed significantly seasonal variations, and varied from 6.91±1.94 $\mu mol \cdot mol^{-1}$ (July 2016) to 105.60±3.09 $\mu mol \cdot mol^{-1}$ (January 2017). We also observed that CO_2ff shared a similar trend over study period with air pollutants and was correlated with air pollutants. By the relationships between CO_2ff and air pollutants, this study qualitatively analyzed the main sources of CO_2ff in different seasons. Due to the different atmospheric diffusion conditions, in spring and summer, CO_2ff at the sampling site may be mainly affected by industrial coal combustion, while in autumn and winter, mainly by vehicles emissions.

Keywords: *^{14}C; fossil fuel CO_2; Xi'an*

Carbon-14 age calibration and archaeological application

P-20

Potential ^{14}C excursions in the available radiocarbon calibration curve data

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It has been supported by numerous works following Miyake discovery, that there were some rapid changes in ^{14}C concentration in the atmospheric carbon dioxide. Although the origins of these changes are not well recognized, they are of the radiocarbon community attention because of the potential use in precise radiocarbon dating. Previously published results of researches suggest that the changes have been observed for periods no longer than couples of years with the amplitude of several per miles and rise time of a year or less. We made a survey of available data used to build IntCal'13 radiocarbon calibration curve. Datasets which are potentially suitable for the investigations of rapid ^{14}C were selected. For some periods of time we tried searching for potential atmospheric ^{14}C concentration excursions. We will present the results of our investigations.

Keywords: *calibration curve; Miyake effect; radiocarbon*

Carbon-14 age calibration and archaeological application

P-21

Applications of Miyake effect in construction of absolute dendrochronological scale

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Miyake *et al.* [1,2,3] described a sudden increase of radiocarbon (^{14}C) concentration in annual tree rings of Japanese cedar (*Cryptomeria japonica*) and Hinoki cypress (*Chamaecyparis obtusa*) between AD 774 and 775 and between AD 993 and 994. In both analysed periods, the sudden increase was observed almost in a single year. Due to the characteristic of the sharp increase in radiocarbon concentration that occurs in this phenomenon, and due to the global character of this effect, it is possible to use it for accurate dating of annual tree rings, using radiocarbon method. In practice, linking the relative dendrochronological dating and radiocarbon analysis of annual growth rings is possible to use "Wiggle matching" technique to precise determination of the calendar age of samples of pine, from the floating pine chronology (2U_02A) for central Poland. Absolute dating chronology 2U_02A covering 227 year, determined on the basis of 50 individual sequences is of great importance for archaeology of the early Middle Ages. This is particularly important for polish history, as during the period covered by this chronology, evolutionary changes occurred, such us the transition from tribal organization to the state organization and the emergence of a series of fortified towns, which dendrochronology dating without pine standard is difficult. So far, summarized standard curves for pine in Poland date back from the present to 1106 AD for Gdańsk Pomerania [4] and 1091 AD for Lesser Poland [5] and does not include the Xth century AD.

Keywords: *miyake effect; calibration curve; dendrochronology; AMS*

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Carbon-14 age calibration and archaeological application

P-22

775 and 994 ^{14}C event in the tree-rings of northern Japanese trees

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The carbon-14 surge event in AD775 was discovered in the tree-rings of Yakusugi from southern Japan (Miyake *et al*. 2012), and later reproduced on 27 species of trees around the world (Büntgen *et al*. 2018). Such a carbon-14 surge event can be applied to determine the absolute age of floating tree-ring sequences. We call this carbon-14 spike matching. As an example, we dated the 10th century eruption of Mt. Baitoushan in China / North Korea as AD946 (Hakozaki *et al*. 2018).

Currently, we are constructing a tree-ring chronology in a northern Japan area based on oxygen isotope ratio. However, because of its historical background, the northern Japan area lacks long-lived trees. Therefore, the chronology has not been continuous data yet, and absolute ages for several time intervals are not determined. In order to determine the absolute age, we tried to reproduce the carbon-14 events of AD775 and AD994 using the tree-ring samples that components of the chronology. As a result, the AD775 event was clearly reproduced. The AD994 event was less clear than the trees in southern Japan, but was generally consistent with the rest of the world. The absolute age of our tree-ring chronology was determined as AD417-1595.

Keywords: *; Miyake Event; dendrochronology; northern Japan*

Carbon-14 age calibration and archaeological application

P-23

Radiocarbon dating of a shrine pavilion and offerings at Abushina shrine in Gifu prefecture, Japan

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Abushina shrine in Gifu, Japan has many precious cultural properties. Radiocarbon dating of a shrine pavilion and offerings at the shrine was conducted by using JAEA-AMS-TONO, as requested by the shrine parishioners. Samples were pieces of woods collected from the shrine pavilion and the offerings of two lion masks, a donated nameboard of a curtain and a board of a woodcut print made for a charm.

The obtained ages of the shrine pavilion were 1642-1951 cal AD, though it is known that the latest rehabilitation was 1202 y. This suggests that the shrine pavilion was rebuilt after Edo Period. The obtained ages of the lion masks, a donated nameboard and the board were 1408-1466 cal AD, 1332-1444 cal AD, 1673-1697 cal AD and 1667-1955 cal AD, resupectivly. The ages of the lion masks were consistent with those etched on thee masks. On the other hand, the age of the donated nameboard was not corresponding to devoted time of the curtain. This shows that the donated nameboard was remade to pass on a record of the dedication for future generations because of the dedication in commemoration of the birth of Mr. Ranmaru Mori, who was one of the famous samurai in Azuchi-Momoyama Period. The age of the board shows that the board was used after Edo Period.

Keywords: *Radiocarbon dating; Shrine pavilion; Offerings; JAEA-AMS-TONO*

Carbon-14 age calibration and archaeological application

P-24

AMS ^{14}C dating on Collagen, TOC and carbonate of bone and tooth samples at the NTUAMS Lab

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Bone and tooth samples are often used for AMS ^{14}C dating in archaeology. However, many such samples were not enough to extract collagen which is considered as the most reliable material for dating. Depending on the preservation conditions, collagen in bones and teeth is often decay or lost through time. Many previous studies have setup dating criterions for bone samples, such as C/N, δ^{15}N and δ^{13}C, etc. Practically, accurate age is not required in many studies, e.g., Holocene or Pleistocene in age would be important for interpreting conclusions in early human settlement in China. In this study, we first establish our dating procedure for bone samples by practice dating a modern bovine bone collected from field in Sichuan Province of China. The collagen extraction method is adapted from Brock *et al*. (2010) and Dunbar *et al*. (2016). The average pMC of the collagen is 104.481 ±0.855% (N = 7). The pMC value of the TOC of the bovine bone is 106.88±0.81%. A human bone and human tooth from Yinxu archaeological site at Anyang City, Henan Province which had a known age of Late Shang Dynasty (1146-1046 BC, or 2996-3096 cal. yr BP) were used to check our dating procedure. The AMS ^{14}C ages of the collagen and TOC of the bone and TOC of the tooth are 3015±100, 2655±115 and 2990±100 (cal. yr BP), respectively, showing the collagen of the bone and the TOC of the tooth have very close to the known age, but the TOC of the bone is younger than the collagen. AMS ^{14}C dates of collagen and TOC of animal tooth from four caves in south China show that the TOC ages are less than 50% younger than the collagen ages within Holocene, no more than one order magnitude younger even for late Pleistocene samples. All the ^{14}C ages of the collagen and TOC of the animal and human teeth from the four caves are younger than 40,000 yr BP, reflecting the human settlements could not be as early as 90-150 ka which was determined by U-series dating on speleothems of the stratum.

Keywords: *collagen; bone;* ^{14}*C; AMS; dating*

P-25

The spatial distribution of shell ^{14}C ages in China.

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The use of the aragonite shells for ^{14}C dating is restricted by the well-known limestone problem, many researchers only consider the effect of snail size on absorption of calcium carbonate, ignore the growing environment of snail. In order to further elucidated the possibility of land snail shells for radiocarbon dating, the modern land snail shells were collected from middle part of China to Hainan Island in this work. In the carbonate area, distributed in northern China, the snail shell age is relatively old, ranging from 2400 to 400 years. However, in the no carbonate area, distributed in southern China, shell ^{14}C dating results show modern origin. In southern China, soluble salt and carbonate in the soil were leached out, and the calcium content was about 1 %, The favorable growth environment in the south encourages snails to eat a lot of plants to make up for the lack of calcium. therefore, there are many modern carbons from plants in the shell, Brazilian *et al*., 2017 also found the shell were not affected by old carbon in Brazil. Brazil is in the subtropical region, and the living habits of snails are relatively similar to those in the southern China. Whether the shell can be used as a reliable ^{14}C dating material, not depends on the size of snail but on the growing environment of snail. In the no carbonate area, reliable ^{14}C dating can be achieved by using the terrestrial fossils shell discovered in the strata and archaeological sites.

Keywords: *shell; Radiocarbon*

Carbon-14 age calibration and archaeological application

P-26

Radiocarbon dating and diet analysis of cremated bones excavated from archaeological sites in Japan

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Radiocarbon dating and dietary analysis were performed on cremated bones excavated from two archaeological sites in Japan. The samples used are the remains of Jokei, a Buddhist monk (AD 1155–1213), found in an urn from the Jisho-in Temple, Nara Prefecture, Japan, and several cremated bones excavated from the Ishibotoke-dani archaeological site in the Binman-ji Temple, Shiga Prefecture, Japan. The Ishibotoke-dani site, which is divided into 7 areas of A to G, is a large medieval grave used from the 13th to the 16th century. It is estimated that influential people from the region were buried in the site.

The cremated bones of Jokei were analysed for eight bone fragments of different colors (black, gray, and white). The white fragments had the highest apatite crystallinity and the lowest Ba concentrations. The calibrated date of the white bone fragments is 1152–1216 cal AD, consistent with Jokei's lifespan, showing these fragments provide reliable ^{14}C ages. Meanwhile, the black and gray fragments, which probably experienced lower temperatures during cremation, had lower apatite crystallinity and higher Ba concentrations. These results indicate that bioapatite in white cremated bone is resistant to diagenetic alteration, while bioapatite in black and gray bones is affected by soil contamination [1]. The Sr/Ca and δ^{88}Sr dietary analyses using the white bone fragments of Jokei suggested his vegetarian diet. The result is consistent with the religious precept that meat eating was prohibited for monks under Mahayana Buddhism.

The white cremated bones from the Ishibotoke-dani site had high apatite crystallinity and low Ba concentrations, showing that they may have been exposed to high temperatures and are resistant to diagenetic alteration. The ^{14}C ages of the white bones from the A and D areas were similar, ranging from 716±36 BP to 738±34 BP, and those from the F area varied largely from 651±37 BP to 896±36 BP. The bone from the G area showed the youngest ^{14}C age of 579±38 BP. The results show that the ^{14}C ages of cremated bones in the Ishibotoke-dani site are different by the burial areas. Meanwhile, the diet analysis of the bones by Sr/Ca and δ^{88}Sr showed that their trophic level was higher than Jokei, indicating that the influential people in the medieval period ate meats as well as vegetables.

Keywords: *Radiocarbon dating; diet analysis; cremated bones*

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General AMS application

P-27

A plan on accurate radiocarbon dating of ivory products in Japan and estimation of the original areas for providing ivory for legal international trading of ivory products

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In East Asia, personal seals made of animal tusk, stone or wood are widely used, and among these raw materials, ivory is considered to have the highest value. However, in 1973, the Washington Convention (Convention on International Trading in Endangered Species of Wild Fauna and Flora: CITES) gave rise to global prohibition on the trading of endangered species of wild fauna and flora, both living and dead as well as any products made thereof. Elephants were among the endangered species that became protected by the convention. Japan entered into CITES in 1980. About Asian elephant, international trading of elephant tusk and its products from/into Japan was prohibited, except those items purchased prior to 1975 according to CITES prohibition. About African elephant, international trading of elephant tusk items was prohibited unless they were imported before 1990. Use of ^{14}C contents to determine the age of ivory has therefore become important in trade to verify that a given ivory product was not harvested later than 1975 for Asian elephant and 1990 for African elephant, if no official documentation exists to prove the age of the sample. Atmospheric concentrations of ^{14}C produced by nuclear bomb tests between 1945 and 1963 show unique secular variations from 1955 to present. These secular variations can be successfully used in age estimations of natural carbonaceous materials formed by incorporating atmospheric CO_2 during this time frame [1].

However, the age of the ivory products does not prohibit completely the international ivory-product trading for African elephant. In 1999 and 2008, legal import of ivory was conducted into Japan from the countries of Republic of Botswana, Republic of Namibia, Republic of Zimbabwe, and Republic of South Africa. The four countries locate southern end of African Continent and elephants may have grown up with different food resources in the four countries compared with those in other northern African countries. The analysis of food habits based on the stable isotope ratios ^{13}C, δ^{15}N, δ^{18}O and δ^{34}S of collagen materials extracted from bones or tusks (teeth) of animals provided great success recently [2]. The isotope analysis provides us useful information about local climate or vegetation conditions for food resources at the locations where those animals have grown up. The DNA sequence analysis is also planned for distinct identification of grown up areas of the elephants. This project is just started to confirm legal international trading of ivory products from/into Japan.

Keywords: *radiocarbon; bomb-produced radiocarbon; stable isotope ratio CITES; elephant tusk; tusk formation age*

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General AMS application

P-28

Radiocarbon ages of organic carbon in sediments, suspended particles, and benthic invertebrates in Otsuchi Bay, northeastern Japan

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Aged organic matter in soils is transported to estuarine and coastal environments, where it can be assimilated by microbes [1]. This suggests that, via the microbial food chain, the aged organic carbon might support the production of benthic invertebrates in coastal habitats. To test this hypothesis, we used radiocarbon ($\Delta^{14}C$) to investigate the age of organic carbon assimilated by benthic invertebrates in Otsuchi Bay, the Pacific coast of the northeastern Japan. We determined the $\Delta^{14}C$ of benthic invertebrates, belonging to 13 taxa including filter feeders (that ingest particles suspended in seawater) and deposit feeders (that ingest particles comprising sedimentary deposits), and the two forms of organic matter in their surrounding environments; i.e. sedimentary organic matter (SOM) and suspended particulate organic matter (POM) in the water column. Dissolved inorganic carbon (DIC) in the bay water was also analyzed to estimate the possible range of $\Delta^{14}C$ signatures of aquatic primary producers including phytoplankton and benthic algae. The $\Delta^{14}C$ values of invertebrates varied in the range of –9.8 to 42‰, while those of DIC ranged from 3.2 to 35‰. Although the lower $\Delta^{14}C$ values of invertebrates were outside the range of $\Delta^{14}C$ for DIC, they are within the lower range of reported $\Delta^{14}C$ values for DIC in Otsuchi Bay, the lowest value of –57‰ being observed during the intrusion of ^{14}C-depleted, Oyashio water in winter [2]. The $\Delta^{14}C$ values of SOM and POM varied much more widely than DIC depending on location and season, with the ranges of –321 to 30‰ (3046 years B.P to modern) and –150 to 4.0‰ (1240 years B.P. to modern) for SOM and POM, respectively. The analysis of the relationships between $\Delta^{14}C$, carbon stable isotope signature and C/N ratio suggested that SOM was the mixture of modern carbon derived from terrestrial vascular plants and the old carbon presumably derived from sedimentary rocks, and POM was the mixture of modern carbon derived from marine phytoplankton and aged soil organic carbon. Thus, despite the fact that the $\Delta^{14}C$ signatures of SOM and POM clearly indicated a significant transport of aged organic carbon from its catchment to Otsuchi Bay, benthic invertebrates in this bay appeared to assimilate only modern carbon originated from contemporaneous autotrophs.

Keywords: *Radiocarbon; food source; benthic invertebrate*

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General AMS application

P-29

Radiocarbon ages of POC, DOC, and DIC in ground ice in Siberian permafrost

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The ground ice in permafrost is receiving attention as a useful tool for paleoenvironment reconstruction in northeast Siberia and north central Alaska. For understanding of past climate changes and hydrological environmental changes preserved in the ground ice, it is important to determine the accurate formation age of ground ice. In order to investigate which carbon component is most suitable for determination of the formation ages of ground ice, we measured ^{14}C ages of carbon components of particulate organic carbon (POC), dissolved organic carbon (DOC), dissolved inorganic carbon (DIC) in ground ice samples in permafrost at Syrdakh and Churapcha, near Yakutsk city in Russia. The DOC was divided into three particle-size fractions of 0.7 μm−10 kDa, 10 kDa−3 kDa, and <3 kDa, and the ^{14}C ages of three fractions were measured.

The ^{14}C ages of POC in the ground ice samples, 40−27 kyr BP, were approximately 10,000 years older than plant ages of 24−22 kyr BP. The ^{14}C ages of DOC were different by molecular size: the 0.7 μm−10 kDa and 10 kDa−3 kDa fractions showed 28−19 kyr BP, similar to those of plants, whereas the <3 kDa fraction showed younger ages of 19−12 kyr BP, which were similar to those of DIC, 18−12 kyr BP.

From these results, the POC is likely to have older age due to the influence of redeposition of organic carbon with old age [1], and is not good for use on determining the formation age of ground ice. Meanwhile, the coarse fraction of DOC could be useful for obtaining the true age of ice formation. The DIC and the fine fraction of DOC could show any age except the ice formation age, such as the age of permafrost thawing due to abrupt northern hemispheric warming at the Bølling/Allerød, (~14,6 kyr BP) [2]. The cause of age difference in three carbon components in ground ice will be discussed.

Keywords: *Radiocarbon age; grond ice; permafrost; DOC*

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General AMS application

P-30

A ^{129}I/^{127}I data collection of marine biota

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^{129}I (half-life 15.7 million years) has been produced by cosmic-ray production and natural fission processes in natural environment. After nuclear age, huge amount of anthropogenic ^{129}I was released during nuclear weapons testing and operations of nuclear facilities. Isotopic ratio of ^{129}I divided by stable iodine (^{129}I/I) in surface seawater has varied several digits after nuclear age [1]. Since iodine is a biophile element, anthropogenic ^{129}I was taken in biosphere and ^{129}I/I would also be changed compared before nuclear age.

In this study ^{129}I/I data was obtained for 123 biota samples which are collected from the northeast Atlantic Ocean, the Pacific Ocean, and the east Indian Ocean. Most of biota samples were collected on Japanese research cruises carried out on the north west Pacific Ocean, and the other samples such pelagic fish and old ones were provided by Environmental Specimen Bank (es-BANK), Ehime University, Japan. Year of sampling distributes from 1966 to 2014. ^{129}I/I ratio was measured by Accelerator mass spectrometry (AMS), and inductively coupled plasma mass spectrometry (ICP-MS) at Micro Analysis Laboratory, Tandem Accelerator (MALT), the University of Tokyo.

Isotopic ratio of biota showed latitude dependence as that of seawater reported by literatures [e.g. 1, 2]. Isotopic ratio of fish from the northeast Atlantic Ocean drastically increased from 2×10^{-10} before 1993 to 8×10^{-8} to 2×10^{-7} after 1996. This is related to liquid discharge from spent nuclear fuel reprocessing plants [3]. The lowest value, 8×10^{-12}, was detected with a fish collected at the western coast of Argentina in 1978. ^{129}I/I of other samples from the Southern Hemisphere collected in 1978-2005 distributed 1×10^{-11} to 3×10^{-11} (n = 6).

We also measured ^{129}I/I of iodide and iodate in seawater samples and compared them with ^{129}I/I of biota samples collected at same station. As a result, ^{129}I/I of iodide agreed with that of biota. This suggests iodide is biophile chemical form in the ocean.

Those results show ^{129}I/I of biota represents their habitat environment and iodide would be a clue for understanding iodine system in marine biosphere.

Keywords: *Iodine-129; marinebiota; seawater*

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General AMS application

P-31

Preliminary test for ^{129}I measurement of $CaCO_3$ samples in JAEA-AMS-TONO

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A preliminary test for AMS ^{129}I measurement of $CaCO_3$ samples was performed using a tandem Pelletron AMS system at Tono Geoscience Center, Japan Atomic Energy Agency (JAEA-AMS-TONO). An annually-banded coral collected from Con Dao Island, Vietnam, was used for this test. The procedure of the test was as follows: (1) an annual-band sample of AD 1946-47 (in the pre-nuclear-test period) from the coral was treated with 1% HCl for removal of its surface portion, resulting in ~8% weight loss of the sample; (2) the treated sample was dissolved in 17% H_3PO_4 solution; (3) a small aliquot from the sample solution was used for ^{127}I measurement by ICP-MS; (4) the Woodward iodine standard dissolved in Na_2SO_3(aq) was added as a carrier to the sample solution; (5) iodine was extracted from the solution by solvent extraction and back-extraction using n-hexane and Na_2SO_3(aq), respectively, resulting in an aqueous phase with extracted iodine; (6) $AgNO_3$(aq) was added to the aqueous phase to obtain AgI precipitate; (7) the AgI precipitate was mixed with Nb powder and then pressed into a copper cathode for ^{129}I measurement by JAEA-AMS-TONO. A blank test of this procedure was also made to evaluate the background ^{129}I effect in the sample preparation. Results we obtained were as follows: (1) the background $^{129}I/^{127}I$ ratio was $[4.3 \pm 0.1] \times 10^{-14}$ (n = 3) and (2) the background-corrected coral $^{129}I/^{127}I$ ratio was $[1.53 \pm 0.76] \times 10^{-12}$ (n = 4); the latter value was calculated after excluding two abnormally high and low values (originally n = 6). The coral $^{129}I/^{127}I$ ratio is generally in agreement with previously-reported values of AD 1946 and 1947 coral annual bands in Con Dao Island ($[1.51 \pm 0.13] \times 10^{-12}$ and $[0.96 \pm 0.21] \times 10^{-12}$, respectively: Chang *et al.*, 2016), suggesting that AMS ^{129}I measurement of $CaCO_3$ samples has been generally established in JAEA-AMS-TONO. This study was carried out, under a contract with the Agency of Natural Resources and Energy of METI (the Ministry of Economy, Trade and Industry of Japan), as a part of a R&D program for advanced research on long-term stability of geological environment.

Keywords: *iodine-129; $CaCO_3$; coral geology geochemistry*

General AMS application

P-32

Iodine-129 time series records from coastal Taiwan

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This study presents preliminary $^{129}I/^{127}I$ time series data from three coastal sites from Taiwan, collected every two weeks. These include sites at: 1) National Sun-Yat Sen University, Kaohsiung (southwest coast), 2) Zhuwei Fishing Village, Taoyuan (northwest coast), and 3) Yehliu Geopark (northeast coast). Measured $^{129}I/^{127}I$ values at Kaohsiung range from $(35-61)\times10^{-12}$; and those from Zhuwei range from $(43-82)\times10^{-12}$, with a distinct seasonal change observed at the latter site, with lower values during winter and higher values in the spring. We have also documented $^{129}I/^{127}I$ values from five surface ocean sites in the South China Sea, collected during the summer of 2018. These are more tightly clustered, with an average $^{129}I/^{127}I$ value of $(49.6\pm2.4)\times10^{-12}$. Seawater ^{129}I time series and vertical profiles in the ocean reflect differences in the ^{129}I content of different water masses and surface ocean circulation. ^{129}I is very sensitive to upwelling because surface water $^{129}I/^{127}I$ values are about 50 times higher in surface waters, as compared to deep water. Seasonal (summer) upwelling is known to occur along the west coast of Taiwan in the summer. Hence, the bimonthly time series measurements that we are gathering should show this effect. The broader goals of the project include ^{129}I measurements on freshwater, soils and organic matter. We have begun testing a wet chemical technique to extract iodine from these materials.

Keywords: *^{129}I; seawater; coral; radiotracer; time series*

General AMS application

P-33

Holocene activity of the Sagiriko fault detected from sediment cores and a ground penetrating radar profiling, Izu Peninsula, central Japan

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The Mj=7.3 1930 Kita-Izu earthquake ruptured the N-S trending Kita-Izu fault zone, which is also called as the Tanna fault zone. The fault zone is located in the Izu Peninsula, northern tip of the Izu-Bonin-Mariana arc, and it consists of many sinistral strands and some conjugate dextral ones. The Sagiriko fault located to the south of the Kita-Izu fault zone also consists of N-S trending strands and conjugate ones. A N-S trending strand of the Sagiriko fault is ruptured during the 1930 earthquake, but Holocene activity of the conjugate E-W trending strands of the fault have not been revealed. We analyzed the near-surface structure profiled by ground penetrating radar (GPR) and radiocarbon ages of two drill cores to estimate Holocene activity on the Sagiriko fault. In order to detect detailed location of the fault trace on the surface, we first carried out aerial photograph interpretation and field observation before the GPR and drilling surveys. A ground-penetrating radar profile, which length was about 170 m, was recorded across the fault trace and drilling sites. The drilling sites were distributed in both blocks on the strand of the Sagiriko fault in the study area. The GPR data were collected by common-offset modes using 50 MHz GPR systems (pulseEKKO PRO made by Sensors and Software Inc.), and the station spacing was 0.4 m. Furthermore, we carried out wide-angle measurements, and acquired common mid-point ensembles at the both sides of the fault trace to estimate the electromagnetic wave velocity used in the depth conversion of the GPR sections. The GPR sections after careful data processing show detailed structure above a depth of about 8 m. We interpreted several horizons showing the past seismic events. The horizons were dated by AMS radiocarbon ages of plant fragments and organic soil samples in the drilled cores. The horizons explain the Holocene activity of the E-W trending strand of the Sagiriko fault in the study area. This work was started as a research project funded by the Izu Peninsula UNESCO Global Geopark. This study was partially funded by the Japan Society for the Promotion of Science Kakenhi grant number JP18K03768.

Keywords: *active fault; ground penetrating radar; radiocarbon*

General AMS application

P-34

Radiocarbon age offsets of plants and shells in the Holocene sediments from the Lake Harutori, Pacific coast of Hokkaido, northeast Japan

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In order to identify the chronological changes of the marine reservoir effect in the northeast Japan, the radiocarbon ages of 10 pairs of marine shells and terrestrial plants were measured from one core obtained of lagoon lake sediments[1,2]. This lake locates where the one of highest values were detected in East Asia region. This core of 12.6 meters length was obtained in the central part of the frozen lake in winter, which faces on the Oyashio cold current. This drilling site locates on a tectonic active region in the southwestern Kuril arc associated by the oblique subduction of the Pacific Plate under the Okhotsk Plate[3]. Based on analyses of lithology, molluscan assemblages, and radiocarbon dating, we interpreted three units in order of decreasing age: transgressive tidal flat, transgressive lagoon, deltaic lagoon sediments. The lagoon sediments consisted thin silt layers of varve with terrestrial plant fragments and intercalating some event deposits such as 22 sand layers by tsunamis and 6 volcanic ashes[1,2]. The structure was clearly imaged by a core scanning of a computed tomography (CT) and X-ray fluorescence (ITRAX). The reservoir ages of 10 pairs were obtained from the transgressive tidal flat to deltaic lagoon sediments in the past 9,000 years. Using the chronological change in the reservoir effect, the Lake Harutori sediments will be correlated with the Holocene sediments from the other coastal area around southwestern Japan[4,5,6,7] and South Korea[8,9,10]. The core scanning of CT and ITRAX was performed under the cooperative research program of Center for Advanced Marine Core Research, Kochi University (Accept No. 18B061). This study was partially funded by the Japan Society for the Promotion of Science Kakenhi grant number JP18H01310.

Keywords: *Reservoir effect; Lagoon, radiocarbon; Lake Harutori*

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General AMS application

P-35

Marine reservoir effects in transgressive sediments from the Miyazaki Plain, southeast coast of Kyushu, Japan

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To identify the chronological changes of the marine reservoir effect in the Miyazaki Plain, southeast Kyushu, Japan, the radiocarbon ages of 9 pairs of marine shells and terrestrial plants were measured from transgressive sediments. This core with length of 30 meters was obtained from the southern part of the Miyazaki Plain in southeastern Kyusyu Island, which faces on the Kuroshio warm current. This drilling site locates in an uplift area associated by the subduction of the Philippine Sea Plate [1,2] . Based on analyses of lithology, molluscan assemblages, and radiocarbon dating, we interpreted seven sedimentary units in order of older age: fluvial channel, estuary, prodelta, 7.3 ka tsunami [3] deposit, delta front, delta plain, and artificial soil. These paleoenvironmental changes had been clearly associated by the stronger marine influence than a previous drilling core [4] at ca 9 km upper stream from the coast line along this plain. Reservoir ages of 9 pairs from the estuary to delta plain facies were measured, and they were correlated with the values from transgressive lagoon sediments [4]. Using the chronological change in the reservoir effect, the Miyazaki plain sediments will be also correlated with the Holocene sediments from the other coastal area around southwestern Japan [5,6,7]. This study was partially funded by the Kakenhi grant number JP18H01310 from the Japan Society for the Promotion of Science.

Keywords: *Reservoir effect; radiocarbon dating; Miyazaki, lagoon*

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General AMS application

P-36

Bomb $\Delta^{14}C$ record of a Tridacna gigas from South China Sea: chronology and paleoceanography studies

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A Tridacna gigas shell collected from South China Sea was used for studying “nuclear bomb ^{14}C activity” in surface ocean water. The shell is about 20 kg in weight with 72 cm in length, 37 cm in width and max thickness of 15 cm. Along a sampling track (Track A, 13 cm long) in the relatively transparent area, a total of 30 samples have been taken for AMS ^{14}C dating. Another sampling track (Track B, 6.5 cm long) was taken in the relatively non-transparent area, with 13 AMS ^{14}C dating samples. Up to date, a total of 21 AMS dates show that all samples contain nuclear bomb signal (percentage of modern carbon (pMC) ranging from 102.9% to 114.94%). The highest pMC (114.94%) appeared at 7.9 cm from the inner side of Track A, which reflected the year of 1975 C.E. according to the $\Delta^{14}C$ curves of coral records in South China Sea. Based on the $\Delta^{14}C$ value of the oldest layer (outer most part) of the shell, being 62.9‰, the shell should be younger than 1964 C.E.. Thus, the shell would provide an about 50-year record. Interestingly, a $\Delta^{14}C$ trough appeared at 4.5 cm from the inner side of Track A, which may indicate a $\Delta^{14}C$ depletion of the surface seawater due to lower ^{14}C water mixing. ^{210}Pb dating on the shell shows very low ^{210}Pb activity, so that no chronology information from the ^{210}Pb dating. Future works of Mg/Ca, Sr/Ca, $\delta^{18}O$ and $\delta^{13}C$ as well as lamination counting will help us to understand years, surface seawater temperature, and ocean current mixing in the study area.

Keywords: *Bomb carbon; AMS dating; Biological shell*

General AMS application

P-37

Small sample graphitization for ^{14}C dating using EA-AGE3 at JAEA-AMS-TONO

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Geochronological and geochemical data play an important role in consideration for the possibility of deep underground utilization such as geological disposal. Accelerator Mass Spectrometry is widely used for radiometric dating of geological samples. However, improvement in efficiency of sample preparation techniques and trace analysis are needed for high-time resolution dataset. To improve in efficiency of sample preparation techniques and trace analysis, the elemental analyzer and automated graphitization equipment 3 (EA-AGE3; EA, Elementar AG; AGE3, IonPlus AG) were installed at the Toki Geochronology Research Laboratory, Tono Geoscience Center, Japan Atomic Energy Agency. In this study, small amount graphitization of international standard reference materials (IAEA-C4, C5, C7 and NIST-SRM4990C, less than 0.1 mg carbon) for radiocarbon dating was tested by the EA-AGE3. For the trace analysis, radiocarbon measurements were performed by the AMS system (15SDH-2, National Electrostatics Corporation). In this study, AMS beam adjustment was also performed with small amount standards. The radiocarbon concentrations of the standard materials were good agreement with the consensus values by the international radiocarbon conference within ±2 sigma [1,2]. Because the volume of geological samples is usually limited, small sample graphitization is valuable technique. These results indicate that the EA-AGE3 could be a rapid and useful method for preparation in the small amount analyses by AMS.

Keywords: *JAEA-AMS-TONO; ^{14}C; AGE3; EA; Graphitization*

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General AMS application

P-38

1.2-MV Carbon AMS Experiment in KOMAC-AMS

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The accelerator mass spectrometry(AMS) facility at Seoul National University (SNU-AMS) was transferred to Gyeongju KOMAC (Korea Mluti-purpose Accelerator Complex) and is under commissioning. However, they have not been in operation for a long time and some equipments are aging, failing to increase the acceleration voltage of the tandem accelerator (3-MV Tandetron, HVE) to the rated voltage of 3 MV. Increasing to 3 MV required time for replacement of some parts, it was decided to perform AMS at low terminal voltage to verify the performance of the equipment and the availability of the sample preparation system. Carbon +3 is advantageous above 2 MV, while carbon +2 shows higher charge exchange efficiency below 2 MV. Therefore, the terminal voltage was set to 1.2 MV at the maximum charge exchange efficiency for carbon +2, and carbon AMS was performed. With the newly prepared chemistry lab at KOMAC and the sample preparation system relocated from Seoul National University, we are producing targets for standard carbon samples such as oxalic acid. This poster presents the results of this experiment and discusses the usefulness of the prepared facility.

Keywords: *SNU-AMS; KOMAC-AMS; Carbon AMS*

General AMS application

P-39

AMS Preteatment Method for Biosample Analysis in KRICP

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We describe all the major procedures adopted by the Korea Radio Isotope Center for Pharmaceuticals (KRICP) for the generation of graphite in sealed tubes, largely following the method of Ognibene *et al.*[1] This process included the whole procedure, sample preparation, graphite production, accelerator mass spectrometry (AMS) measuremnt and data processing, but this presentation focuses on chemical pretreatment methods that applies to both our research and commercial activities. There are several steps to chemical pretreatment methods such as sample pretreatment, sealing and oxidation, CO_2 transfer, reduction and targeting. We have studied some conditions by changing the oxidation and reduction parameters. Experiments were conducted to find the optimal conditions by varying the amount of copper oxide during the oxidation process. In the reduction process, the experiment was carried out while varying the amounts of zinc and iron. Reduction was carried out using various amounts of zinc and iron. Finally, we reduce the CO_2 trap time by changing the system to a CO_2 transfer device. These procedures led to an optimal sample for ^{14}C AMS analysis. With optimization of our chemical ratios and time parameters, we can easily make 300 samples per week using a single operator. The KIRAMS laboratory provides complete analytical services, including advice on sample selection, sample preparation and analysis of the resulting ^{14}C data, and will be mergeing these tools with more traditional tools to create a complete microdosing/microtracing center.

Keywords: *^{14}C; pre-treatment; AMS; microdosing*

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General AMS application

P-40

Assessing problems of AMS ^{14}C dating on peat samples by dating Carex species

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JCA core (92 cm) taken from Jinchuan Mire in Jilin Province, China for studying environmental changes during the late Holocene. AMS ^{14}C, ^{210}Pb and ^{137}Cs methods provide average 0.09 cm/yr sedimentation rate over the last 1050 years. Previous AMS ^{14}C dating on mixed Sphagnum and herb plants of JCA showed significant lower Δ^{14}C values than the corresponding atmospheric Δ^{14}C during 1950-2017 CE, with the maximum δ^{14}C of $160 \pm 1.5‰$ at 6.5 cm depth. In this study, Carex lehmanii has been picked-up from every cm of JCA for AMS ^{14}C dating. A total of 51 successful dates from 45 horizons of JCA were generated. Four samples dated by both AMS Labs at NTU and OUC, showed similar results. Other 13 horizons dated by OUC Lab fit with the results of NTUAMS Lab very well, indicating the results are reliable. All samples above 12 cm depth contain "bomb ^{14}C" signal, with the highest δ^{14}C value of $216.8 \pm 1.7‰$ at 5.5 cm depth and larger fluctuations than previous results. Below 21 cm depth, the chronology of JCA was determined by Bacon model using 12 AMS ^{14}C dates of plant remains (Li *et al*., 2019). All ^{14}C dates of Carex samples above 85 cm depth are older (5 to 219 years range) than the modeled ages at the corresponding depths. Below 85 cm depth (850 yr BP), five Carex dates not only younger than the modeled ages at the corresponding depths, but also younger than the Carex dates between 80 cm and 85 cm depths. Our hypothesis on the discrepancies between the Carex ages and the modeled ages is that the old carbon in the dissolved CO_2 (DIC) uptaken by Carex is a function of (1) decomposition of peat plants in deeper layers which is related to plant species and climatic conditions; (2) groundwater table which is related to climatic conditions and drilling sites; (3) micro–topographies (hummocks, lawns and hollows) of the peat growth. Since JCA was from shallow site at NE Jinchuan Mire, it is possible that the above factors were not in favor of old carbon influence about 850 yr BP. As the peat continuously accumulated, factors (1) and (2) would cause variation of old carbon influence on the Carex ^{14}C ages. The Carex AMS ^{14}C dates will help us not only to refine previous age model of JCA, but also to understand hydroclimatic information recorded by JCA.

Keywords: *^{14}C dating; peat; Carex; NE China*

General AMS application

P-41

Chronology construction of a stalagmite from southwest China by ^{14}C, ^{230}Th/U and ^{210}Pb dating methods

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A 65 cm long stalagmite, MJP, from Majiaping town in central Guizhou of China was first dated by MC-ICPMS ^{230}Th/U dating method. The ^{230}Th/U dates from 5 horizons show ages ranging from 4596±1257 to 9320 ±8622 a, with very large uncertainties and some reversal sequences due to low U content (^{238}U = 63-96 ppb) and high Th content (^{232}Th = 4.3-117 ppb). The stalagmite is not suitable for ^{230}Th/U dating. A total of 88 samples with sampling thickness of 1-2 mm were taken from various depths of MJP for AMS ^{14}C dating. Up to date, 48 successful ^{14}C dating results show that calibrated ^{14}C ages range from 1445±110 yr BP to 8595±190 yr BP, with very good age sequences (only 2 dates have slightly reversal). These dates form a polynomial equation: y = 1675+27x-0.0483x2+0.000036x3 (R2 = 0.996), where y is age (yr BP) and x is depth (mm). The high R2 value indicates that dead carbon influence (DCI) was relatively constant, and the AMS ^{14}C dating results are much better than those of ^{230}Th/U dating results. However, the ^{14}C dating indicates that the surface stalagmite has an age of 1445±110 yr BP. Whether this is an initial age caused by DCI through the stalagmite remains a question. A total of 14 ^{210}Pb measurements (Po method) from the top 20 mm show that only the surface (0-1 mm) sample has significant ^{210}Pb activity (2.923 dpm/g). Two ^{210}Pb measurements are 0.48 and 0.45 dpm/g at 1-2 mm and 3-4 mm depths, respectively. The rest of ^{210}Pb measurements are less than 0.1 dpm/g which is the detection limit. The ^{210}Pb dating results cannot provide a confident decay trend. In fact, the ^{14}C ages show three linear trends: 0-3 mm (1450-2000 yr BP) with a slope of 167.2 yr/mm (R2 = 0.909); 3-200 mm (2100-5560 yr BP) with a slope of 19.5 yr/mm (R2 = 0.984); and 200-650 mm (5850-8600 yr BP) with a slope of 6.6 yr/mm (R2 = 0.982). We suspect that the initial 1450-yr ^{14}C age only appears in the upper 3 mm layer in the stalagmite. The ^{14}C dates are able to establish the chronology of the stalagmite. The higher growth rate of the stalagmite during the middle Holocene suggested that the climatic conditions were wet and warm.

Keywords: *Stalagmite; ^{14}C; ^{230}Th/U; ^{210}Pb; Chronology*

General AMS application

P-42

Using ^{14}C dated stalagmite records to reconstruct paleoclimate change in South Siberia

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[2] Key Laboratory of Karst Dynamics, Institute of Karst Geology, CAGS, Guilin, China
[3] Department of Earth Sciences, National Taiwan Normal University, Taiwan
[4] Institute of monitoring of climatic and ecological systems of the Siberian Branch of Russian Academy of science (IMCES SB RAS). Akademicheski ave 10/3. Tomsk 634034. Russia

**Corresponding author. E-mail: hcli1960@ntu.edu.tw*

The high latitude region such as Siberia is very sensitive to climate change, especially under the current warming. However, the human impact and natural variability of the climatic changes in Siberian regions are not clear due to limited high-resolution records. Thus, paleoclimate reconstruction for understanding natural variabilities and human influences in such regions is important. In this study, we report three stalagmite records of two caves (L1 and L2 from Lunnaya Cave: 52°40.729'N, 88°43.854'E, 481 m a.s.l.; H1 from Nadezhda Cave: 52°38.872'N, 88°39.194'E, 550 m a.s.l.) in Altai mountain, South Siberia. Very low U content (^{238}U <100 ppb) and radiogenic Th content (^{230}Th /^{232}Th < 10) of stalagmites H1 and L2 resulted in unsuccessful ^{230}Th/U dating. Instead, we used AMS ^{14}C dating (totally 64 dates) to construct the age models. In addition, we used ^{210}Pb dating, ^{230}Th/U dating, and average growth rate method to estimate the dead carbon influence (DCI) in the stalagmites. After removing the DCI, these three stalagmites covered a depositional record of the last 13 thousand years. The growth rates of these stalagmites ranged from 0.02 mm/yr to 0.4 mm/yr under different conditions, showing fast growth rates under warm/wet conditions and low rates or even hiatuses during cold and dry episodes. Base on the growth rates and stable isotope records, we identified three major cold and dry periods (5.1-6.7 kyr BP, 1.6-2.5 kyr BP, and Little Ice Age) and two major warm and wet periods (13 kyr BP, and 1.0-1.5 kyr BP). The cold and dry conditions during the above periods may link to the enhance of Siberia High. The 2.5 kyr BP cold and dry event was probably the cause of the decline of Scythian Culture.

Keywords: *Stalagmite; AMS ^{14}C dating; Paleoclimate; Siberia*

NOTES

NOTES

NOTES

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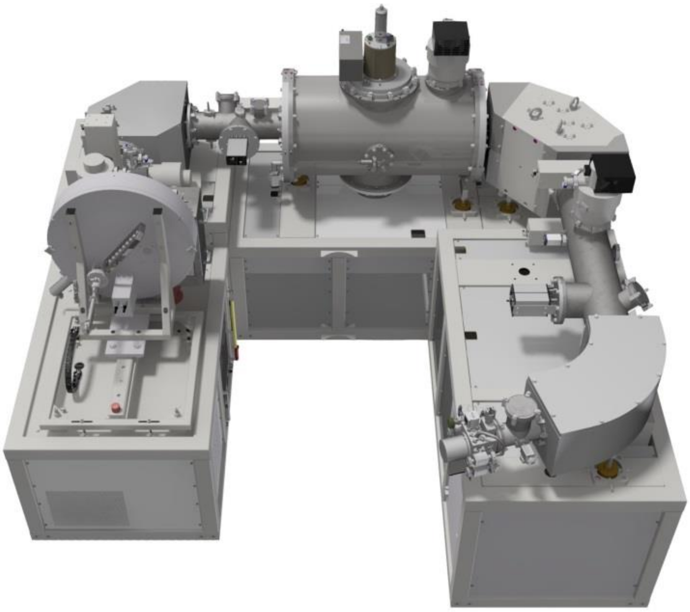

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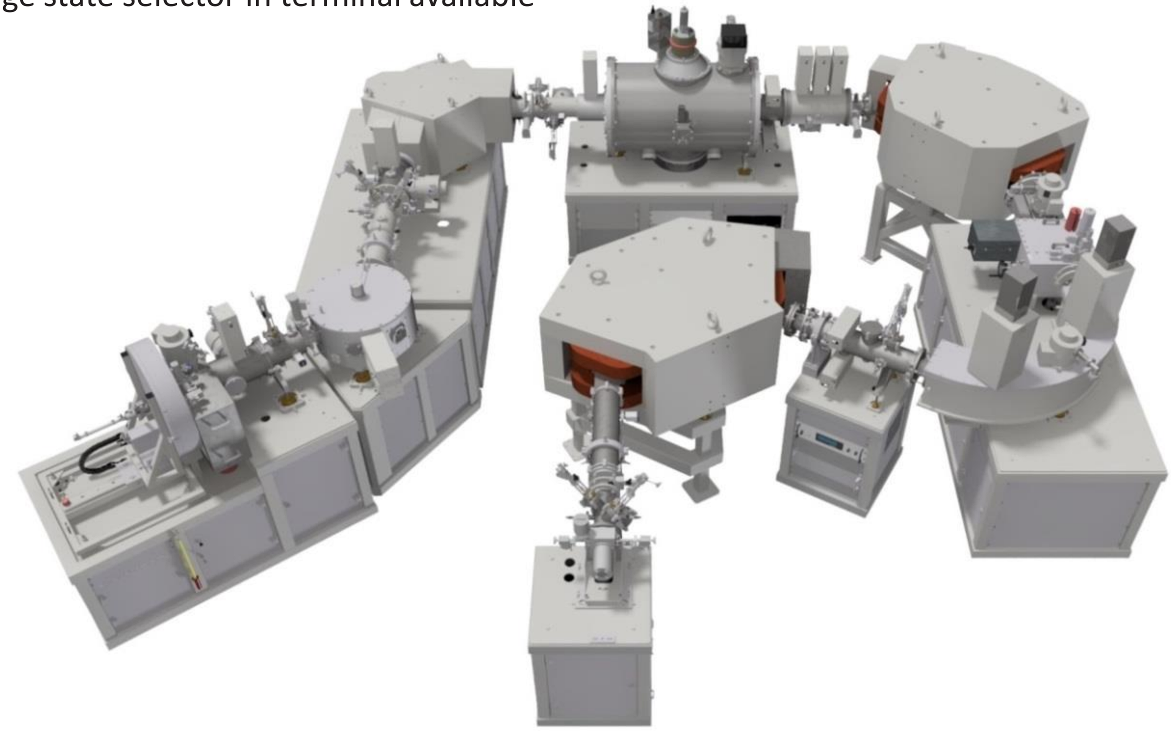

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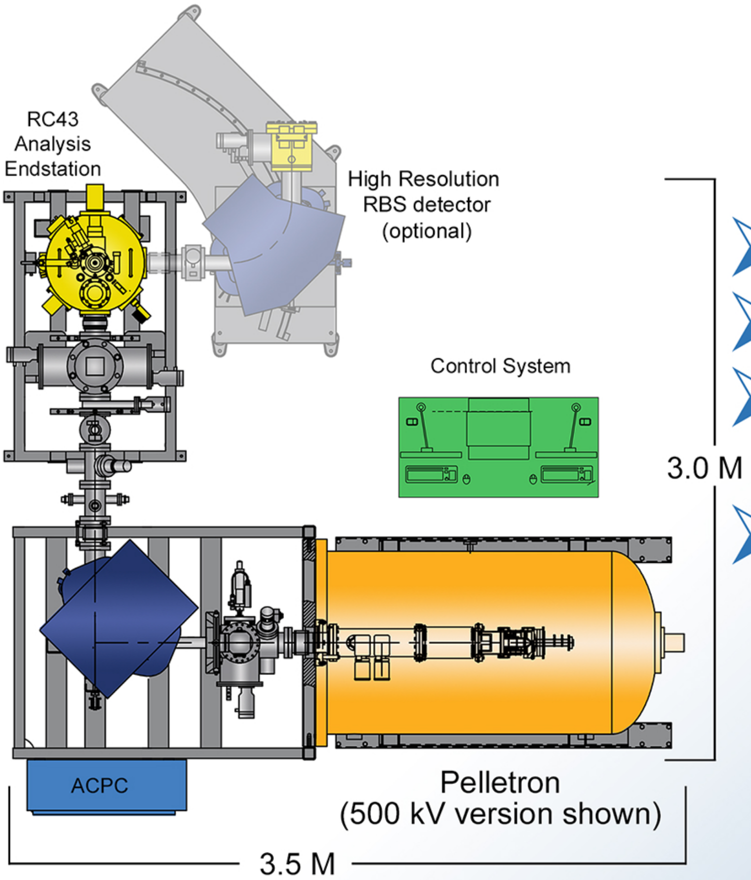

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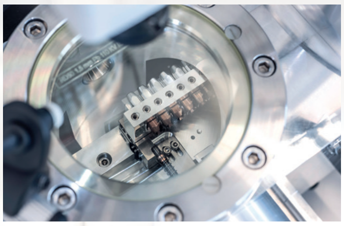

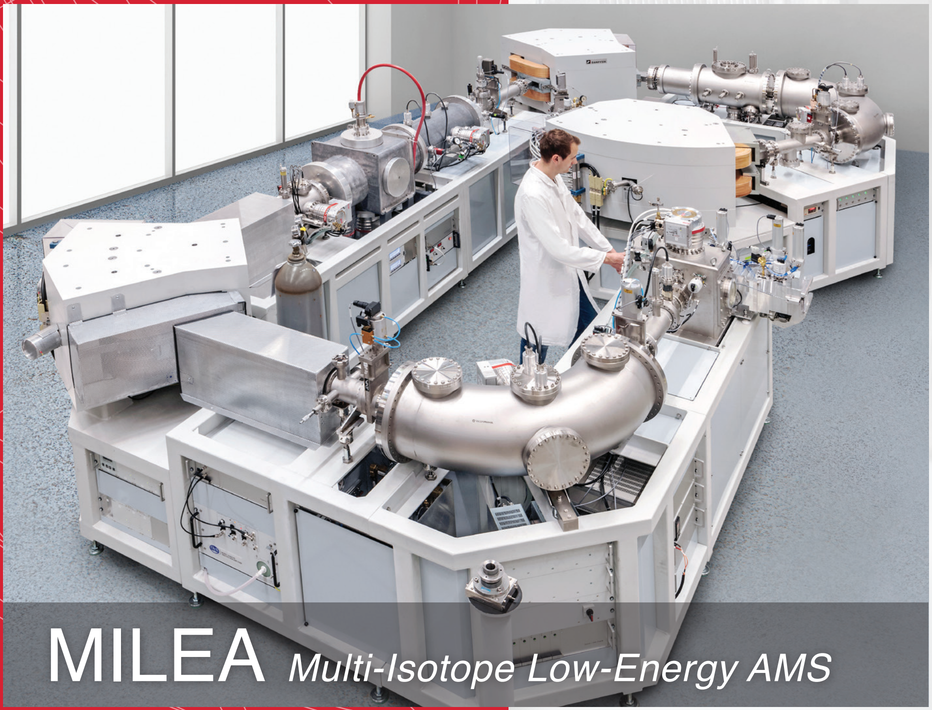
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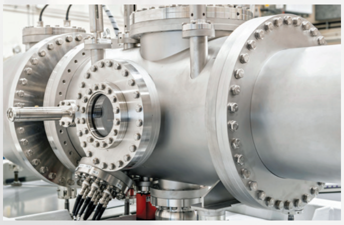

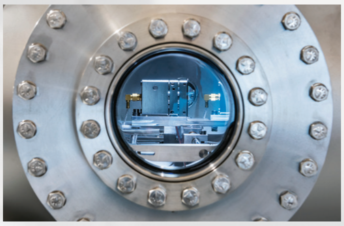

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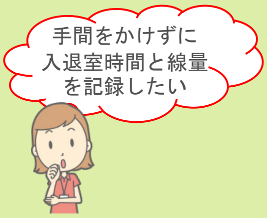

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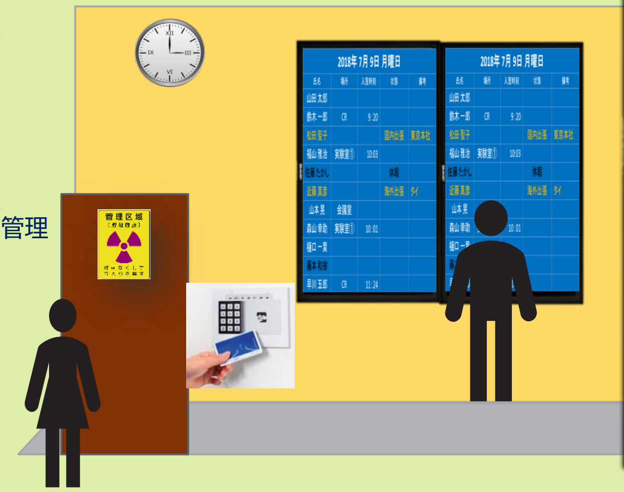

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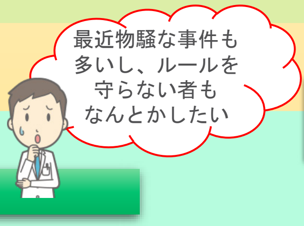
若葉大地	10:12	１ＦＣ
福岡花子	10:12	２ＦＡ
大隅健也	11:04	２ＦＢ
Mike Alpha	11:28	３ＦD
Emma Kelly	11:43	４ＦＡ
鈴木一也	13:16	２ＦＣ



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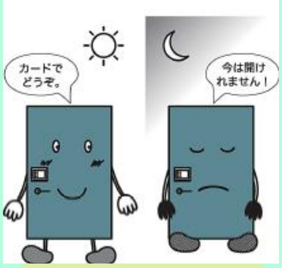

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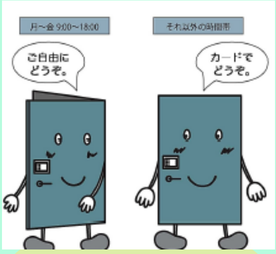

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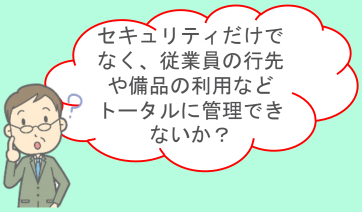

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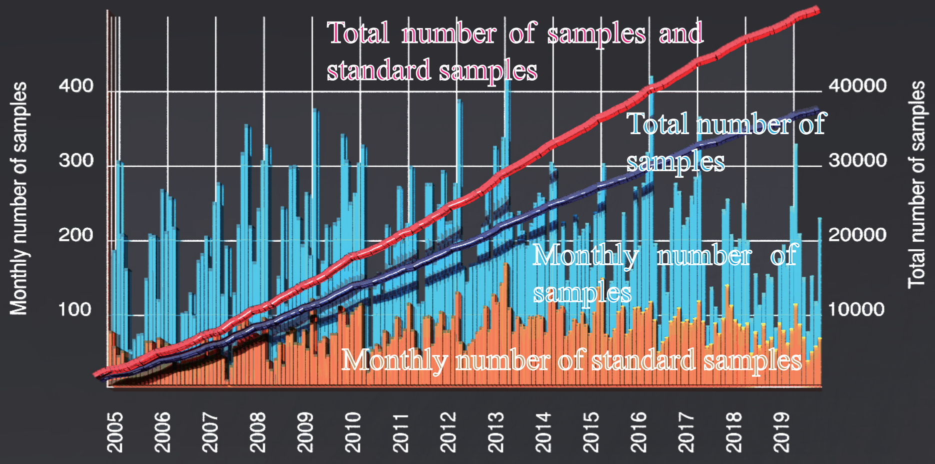

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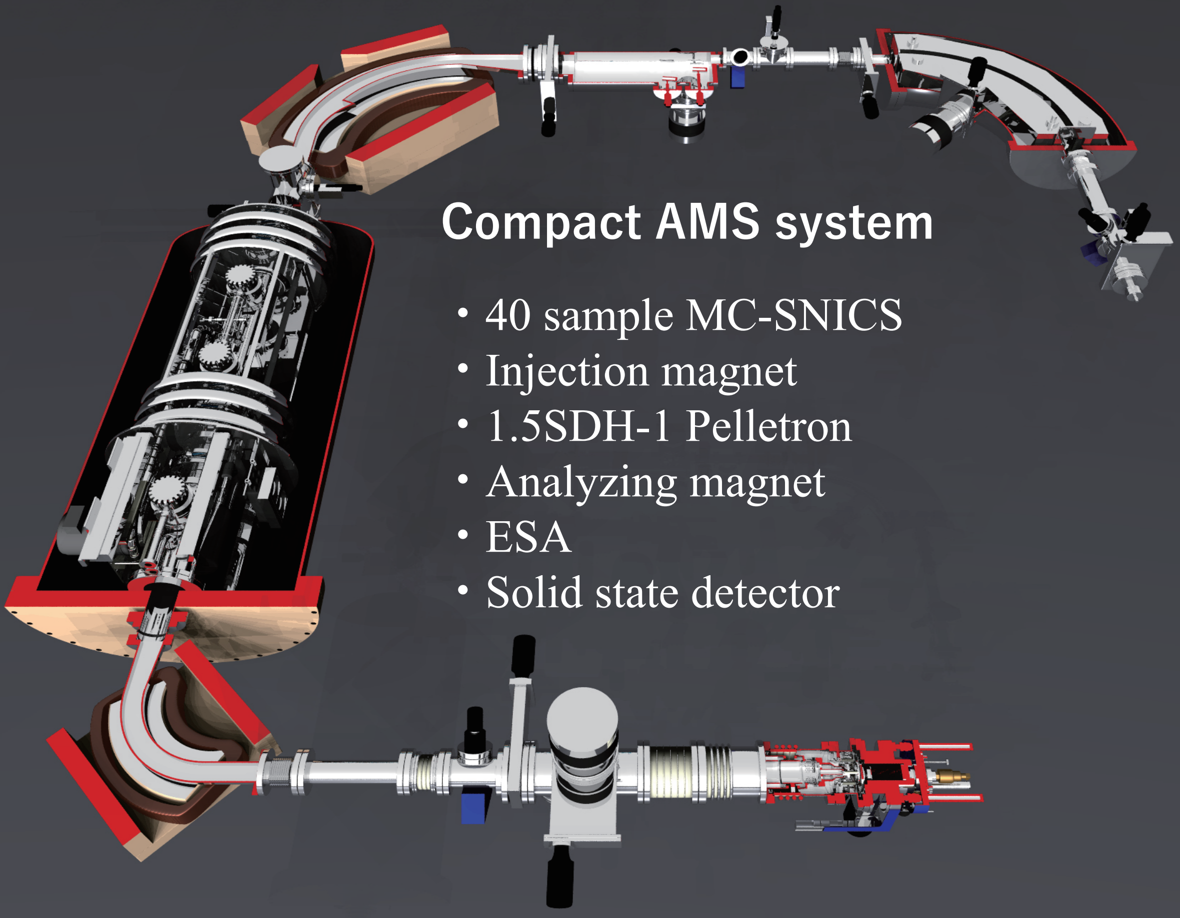

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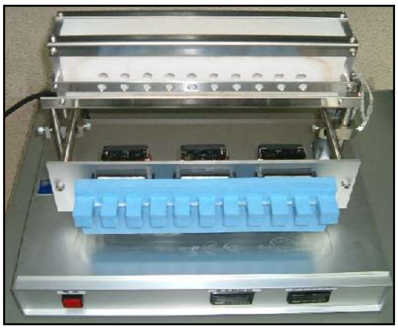

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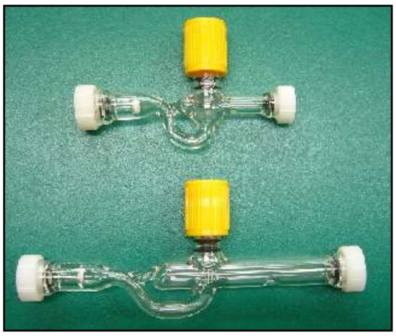

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