BEIJING SHRIMP CENTER

Chinese Academy of Geological Sciences

CHINA GEOLOGICAL SURVEY

Dec. 8, 2006

What is a “SHRIMP”?

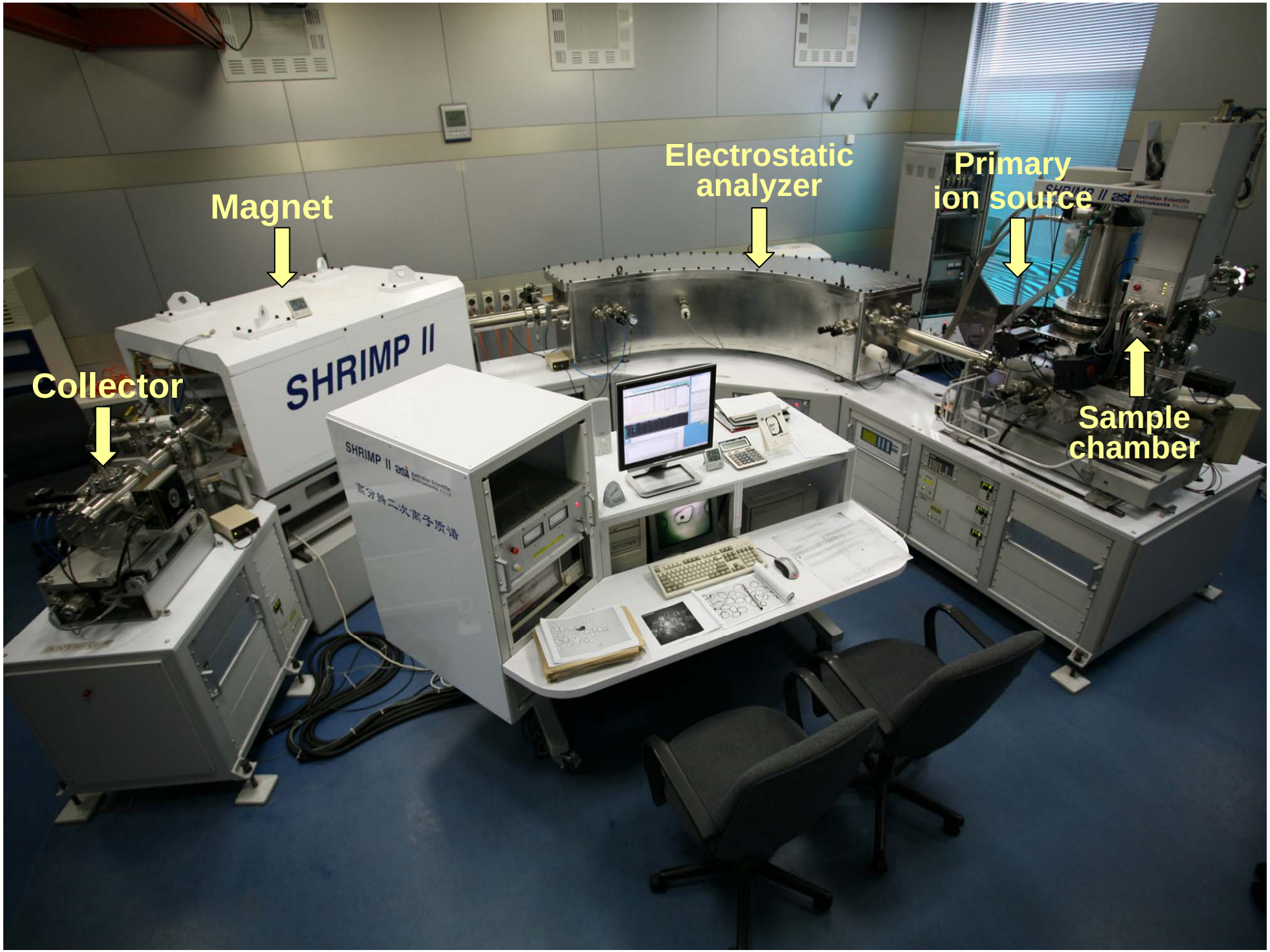
Sensitive **H**igh **R**esolution
Ion **M**icroprobe

Who we are?

- Established on Dec.18, 2001
- National centre for application of large scientific instruments
- Jointly sponsored and shared by
  - Ministry of Land and Resources
  - Ministry of Science and Technology
  - Chinese Academy of Sciences
- Location: Beijing, P. R. of CHINA

What we do?

- Provide high quality geochronological analysis service
- Develop new dating & geochemistry techniques
- Investigate important geological events of Precambrian, as well as geochronology of ophiolite and structural evolution in Central Asian orogenic belts
- Set up the Internet Virtual Lab and Research Center of Micro-beam Analysis Instruments in China
  - Ion Microprobe (SHRIMP II, CAMECA1280)
  - Electron Microprobe (EPMA, SEM)
  - Laser Microprobe (LA-ICPMS)
- Train postgraduates and PhD. Students, as well as engineers and technicians


Magnet
Electrostatic analyzer
Primary ion source
Collector
Sample chamber
SHRIMP II

Technical Features of SHRIMP II

- Mass Resolution: 5000
- Sensitivity: ^{206}Pb--27 cps/ppm
- Precision: for SL13 (Sri Lanka 13; standard age: 572 Ma), the error of $^{206}Pb/^{238}U$ age is less than 1%.
- Dating Range: 1 Ma-4600 Ma

Techniques

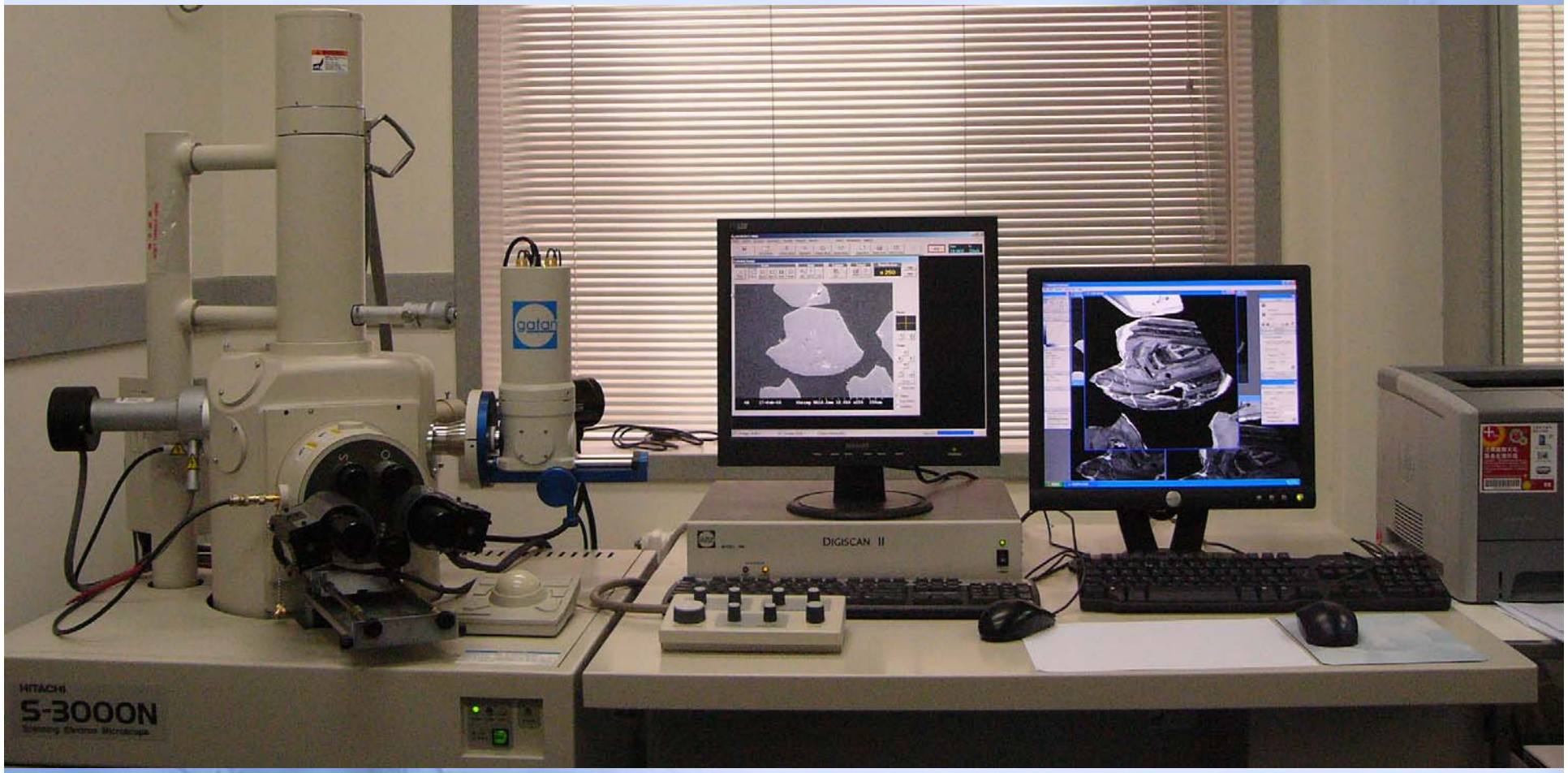
Established:

- U-Th-Pb isotopic analysis of zircon
- U-Th-Pb isotopic analysis of monazite
- U-Th-Pb isotopic dating of apatite
- U-Th-Pb & U-isotopic dating of opal

Under development:

- U- isotopic dating of young zircon
- U-Th-Pb isotopic dating of fluorite

SEM & CL



Operation Principle of the Center

- **High efficiency**

  Key instrument runs 24 hours per day and 7 days a week.

- **Open to the world**

  Visitors may analyze samples and obtain the data by themselves.

Usage of SHRIMP II

Client	SHRIMP Running Time (Day) (1 machine day = 24h)			
	2002	2003	2004	2005
CAS	50.5	58.5	56	63
Universities	45.5	63.5	86.5	51
MLR	95.5	93	151.5	149.5
Taiwan & Hongkong	21	14	6	9.5
Overseas	33	41	-	26
Others	-	1.5	1	-
Total	245.5	271.5	301	299

Highlights of the Center's Operation

- Discovery of 3.8 Ga oldest rocks in China and research on Archean evolution of Anshan (won the 1st prize of Science & Tech Results of Ministry of Land & Resources in 2004)
- Dating of the 4323 Ma zircon core and its 3676 Ma metamorphic overgrowth.
- Journal paper publications based on the experimental data obtained from SHRIMP II of the Center.
- Successful development of SHRIMP Remote Operation System (SROS) and setup remote workstations in Brazil and Yichang, respectively.

Archean Evolution of Anshan Area, Northern China

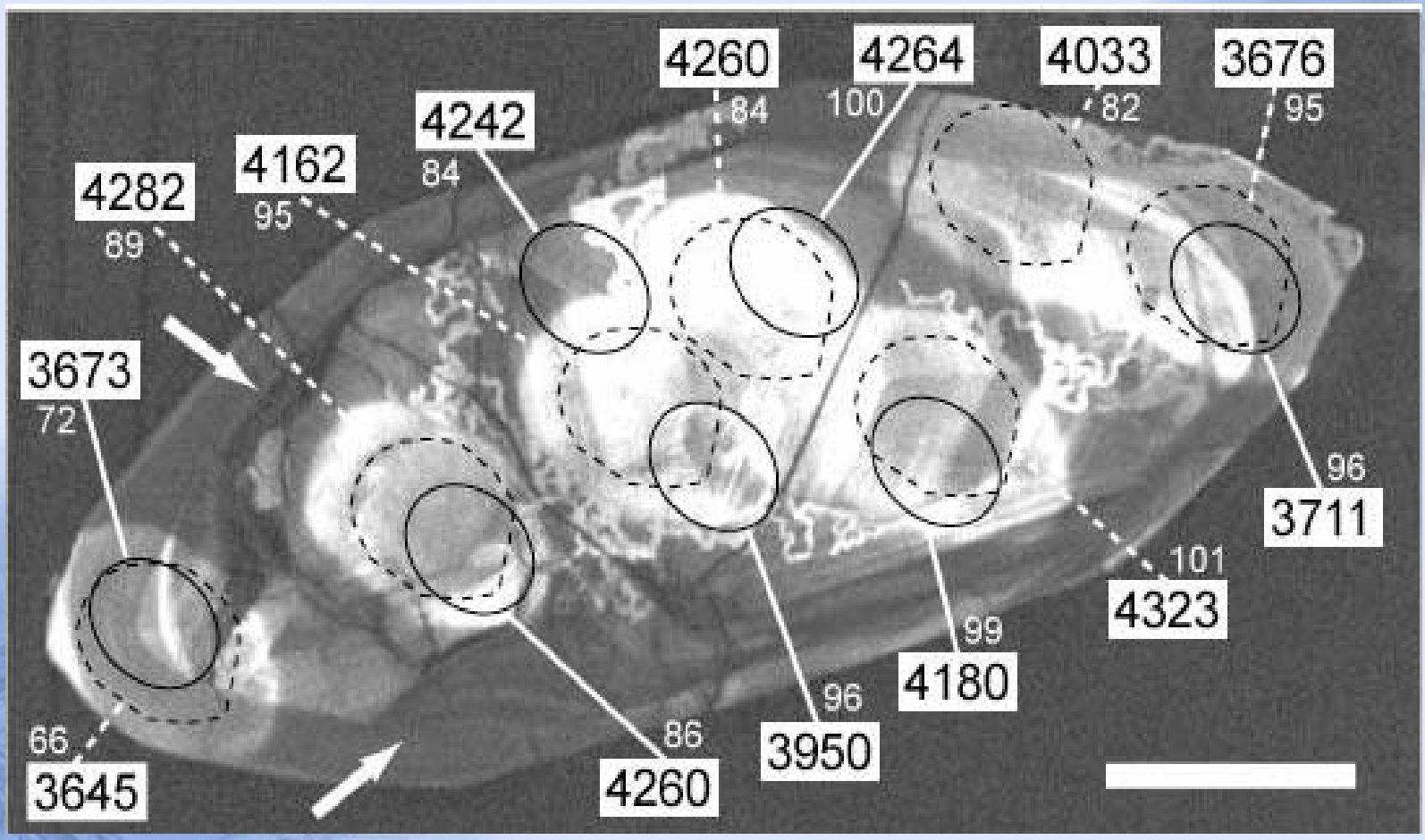
- **Anshan area is one of the four places in the world where rocks older than 3.8 Ga have been discovered** (The other three are Greenland, northwestern Canada and eastern Antarctica).

- **There are 3 types of 3.8 Ga rocks at Anshan: Baijiafen trondhjemite; Dongshan banded trondhjemite; and Dongshan meta-quartz diorite.**

- **The geological features discovered here have recorded a succession of geological events that span the Archean (from 3.8 Ga-2.5 Ga). By dating them, it is possible for us to better understand the Archean tectonic evolution of this area.**

- **Anshan is a very unique region in geology in the world and it is especially important for studying the formation and evolution of early continental crust.**

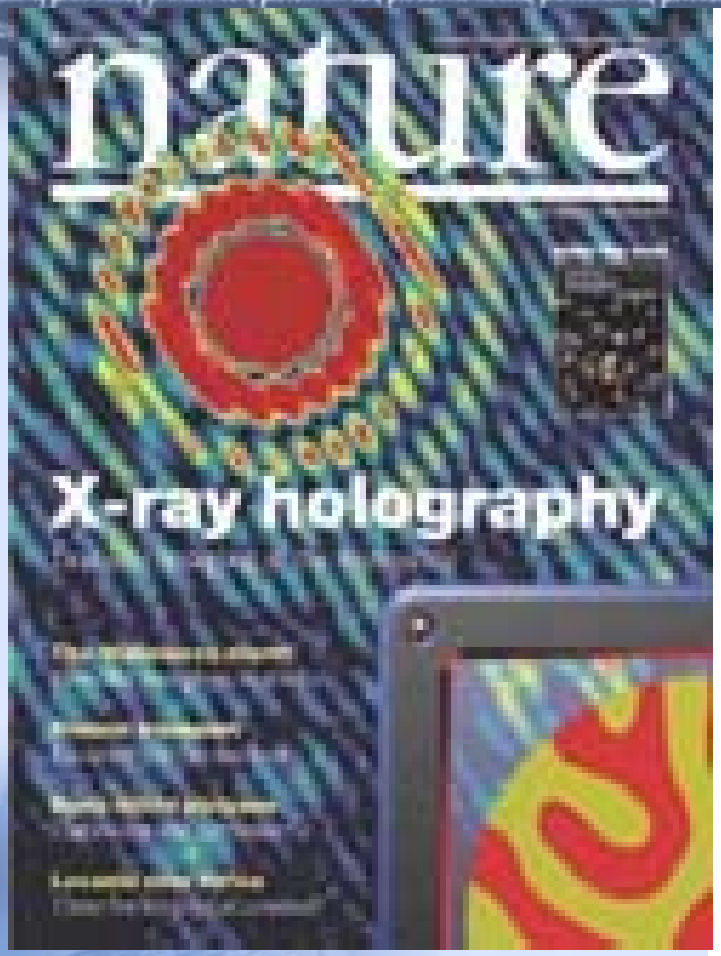
Oldest Zircon – 4323 Ma



Metamorphic Overgrowth—3676 Ma

Journal Paper Publications

Year	Total Papers	International Papers
2003	33	4
2004	73	8
2005	78	11



agreement with the known physiological adaptation to temperature of the tetraether membrane lipid composition in cultured hyperthermophilic Archaea and their marine mesophilic descendants[29]. Previous studies have also shown that the TEX_{86} parameter is not sensitive to salinity or depositional redox conditions[29,30]. Furthermore, initial applications show that reconstructed SSTs for Cretaceous sediments agree well with those derived from oxygen-isotope ratios of pristine skeletal carbonate[16].

Bulk organic isotopes and TOC contents were determined by decalcifying powdered rock samples with 2 N hydrochloric acid and analysing the decalcified sediments in duplicate on a Carlo Erba 1112 Flash Elemental Analyser coupled to a Thermofinnigan Delta Plus isotope mass spectrometer. Analytical errors for TOC range from 0.3% to 2%, and for $\delta^{13}C_{org}$ (‰ versus VPDB) are <0.1‰.

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1. Clark, D. L. Early history of the Arctic Ocean. *Paleoceanography* 3, 539–550 (1988).
2. Clark, D. L., Byers, C. W. & Pratt, L. M. Cretaceous black mud from the central Arctic Ocean. *Paleoceanography* 1, 265–271 (1986).
3. Mudie, P. J. & Blasko, S. M. in *Initial Geological Report on CESAR: The Canadian Expedition to Study the Alpha Ridge* (eds Jackson, H. R., Mudie, P. J. & Blasko, S. M.) 59–99 (Paper 84–22, Geol. Surv. Canada, Ottawa, 1985).
4. Firth, J. V. & Clark, D. L. An early Maastrichtian organic-walled phytoplankton cyst assemblage from an organic-walled black mud in Core FI-533, Alpha Ridge: evidence for upwelling conditions in the Cretaceous Arctic Ocean. *Mar. Micropaleont.* 34, 1–27 (1998).
5. Jokat, W. Seismic investigations along the western sector of Alpha Ridge, Central Arctic Ocean. *Geophys. J. Int.* 152, 185–201 (2003).

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Competing interests statement The authors declare that they have no competing financial interests.

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Recycling lower continental crust in the North China craton

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Methods

U–Pb dating

Zircons from the volcanic rocks were dated on a SHRIMP II at the Beijing SHRIMP Center and on an excimer (193 nm wavelength) laser ablation inductively coupled plasma mass spectrometer (LA-ICP-MS) at the Key Laboratory of Continental Dynamics, Northwest University. The ICP-MS used is an Elan 6100 DRC (Dynamic Reaction Cell) from Perkin Elmer/SCIEX (Canada). The GeoLas 200M laser-ablation system (MicroLas, Göttingen, Germany) was used for the laser ablation experiments. Backscatter electron and cathodoluminescence images (Supplementary Figs 1–3) were made of the zircons before analyses. Uncertainties in ages are quoted at the 95% confidence level (2σ). Spot diameter was 30 and 30–40 μm for SHRIMP II and LA-ICP-MS, respectively. Common Pb corrections were made using measured ^{204}Pb (Supplementary Tables 1, 6).

The SHRIMP II analyses followed established methods[29]. The calibration standard is Sri Lankan gem zircon standard (SL13), and the internal standard is the Australian National University zircon standard TEMORA 1 (ref. 30).

For LA-ICP-MS analysis, raw count rates were measured for ^{29}Si, ^{204}Pb, ^{206}Pb, ^{207}Pb, ^{208}Pb, ^{232}Th and ^{238}U. U, Th and Pb concentrations were calibrated by using ^{29}Si as an internal standard and NIST SRM 610 as the reference standard. ^{202}Hg is usually <10 counts per second in the gas blank. Therefore, the contribution of ^{204}Hg to ^{204}Pb was negligible and no correction was made. $^{207}Pb/^{206}Pb$, $^{206}Pb/^{238}U$ and $^{208}Pb/^{232}Th$ ratios

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4.3. Ion microprobe (SHRIMP II) U–Th–Pb isotopic analysis

Zircons in Au-coated mounts were analyzed during the course of 10 analytical sessions totaling ~200 h over a ten month period. The majority of the analytical work was undertaken on SHRIMP II at the Chinese Academy of Geological Sciences in Beijing, with a few additional analyses performed using the SHRIMP II at Curtin University (run 5). In situ U–Th–Pb age determinations on ~25 μm diameter spots in individual grains were made following standard operating procedures (Nelson, 1997; Williams, 1998). A complete analysis consisted of seven cycles of measurements at each mass ($^{196}(Zr_2O)$, ^{204}Pb, $^{204.045}Pb_{(bkg)}$, ^{206}Pb, ^{207}Pb, ^{208}Pb, ^{238}U, $^{248}(ThO)$, and $^{254}(UO)$). To increase the overall number of grains surveyed, all of the zircons were first analyzed in 'reconnaissance' mode, where only one cycle of measurements lasting ~3 min was made. The precision of single-cycle analyses was lower by up to a factor of 5, however, accuracy was typically

A total of
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(Table 2).

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Internal zoning and U–Th–Pb chemistry of Jack Hills detrital zircons: a mineral record of early Archean to Mesoproterozoic (4348–1576 Ma) magmatism

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Abstract

Magmatic processes were important on the nascent Earth during the first 500 million years (Ma) after accretion, yet the causes and timing of this early magmatism are largely unconstrained, as no rocks from this period have been discovered.

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Journal Paper Publications

- Chung S. L., Liu D. Y., Ji J. Q. et al. 2003. Adakites from continental collision zones: Melting of thickened lower crust beneath southern Tibet. *Geology* 31(11):1021~1024.
- Zhao Z.-F., Zheng Y.-F., Wei C.-S. et al., 2005. Zircon U-Pb age, element and C-O isotope geochemistry of post-collisional mafic-ultramafic rocks from the Dabie orogen in east-central China. *Lithos*, 83:1-28
- Wang Yanbin, Liu Dunyi, Tang Suohan, 2004. Isotopic geochemistry and SHRIMP U-Pb geochronology of mafic-felsic granulites from Larsemann Hills, East Antarctica. *Geochimica et Cosmochimica Acta*, 68(11S):663
- Yusheng Wang, Renwei Li, Simon A. Wilde, Dunyi Liu, et al, 2005. UHP metamorphism and exhumation of the Dabie Orogen, China: Evidence from SHRIMP dating of zircon and monazite from a UHP granitic gneiss cobble from the Hefei Basin. *Geochimica et Cosmochimica Acta*, 69(17): 4333 ~ 4348.
- Kuzmichev A, Kroner A, Liu Dunyi, Wan Yusheng, 2005. The Shishkhid ophiolite, northern Mongulia: A key to the reconstruction of a Neoproterozoic island-arc system in central Asia. *Precambrian Research*, 138: 125-150.
- Shihong Zhang, Ganqing Jiang, Junming Zhang, Biao Song, Martin J. Kennedy, Nicholas Christie-Blick, 2005.U-Pb sensitive high-resolution ion microprobe ages from the Doushantuo Formation in south China: Constraints on late Neoproterozoic glaciations., *Geological Society of America*, 33(6):473–476;

Annual Symposium

Annual symposium of Beijing SHRIMP Center has become an active platform of scientific exchange for the geological community in China.

International Collaboration

- Since 2004, the Center has signed cooperation agreements with many oversea organizations:
  - University of São Paulo, Brazil
  - CRPG (Centre de Recherches Pétrographiques et Géochimiques)-CNRS(Centre National de la Recherche Scientifique), France
  - Curtin University of Technology, Australia
  - Università degli Studi di Milano, Italy
  - Università degli Studi di Milano-Bicocca, Italy
  - All Russian Geological Research Institute
  - Institute of Geology and Mineral Resources, Mongolian Academy of Sciences, Mongolia

  ……

International Symposium in 2007

- **International Symposium on Precambrian Chronology and Tectonic Evolution (ISPCTE)**

- **IGCP-480 workshop**

  (IGCP-480 Project: Structural and Tectonic Correlation across the Central Asia Orogenic Collage: Implications for Continental Growth and Intracontinental Deformation)

SHRIMP Remote Operation System

(SROS)

Jointly developed by:

Beijing SHRIMP Center

National Institute of Metrology, P.R. China

Jilin University

Significance of Sharing SHRIMP with Remote Users

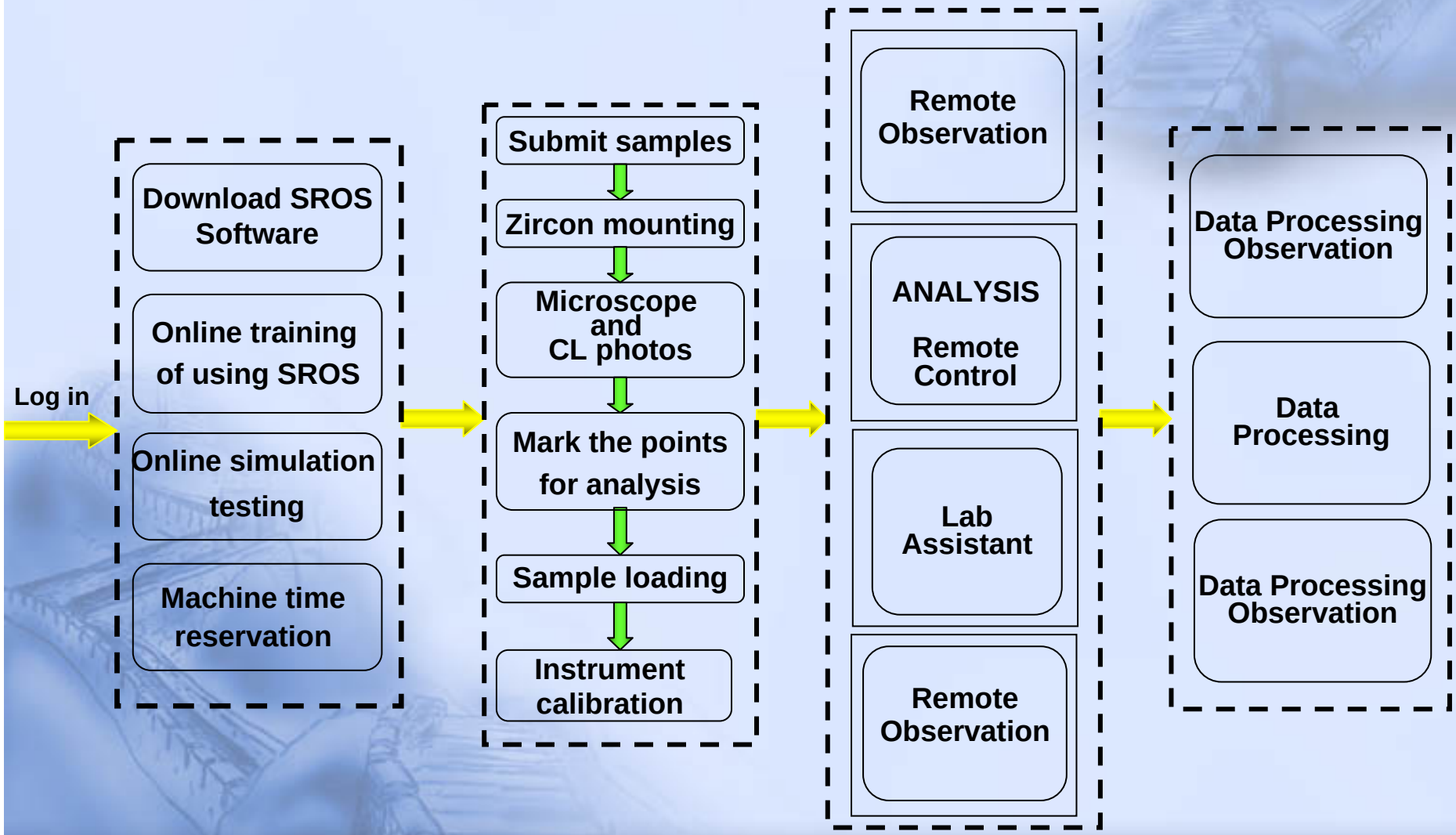
- Reasons for sharing SHRIMP by remote operation:
  - SHRIMP is expensive (€2,000,000)
  - SHRIMP is rare (Only 9 SHRIMPs are in operation now)
  - High demand of machine time (full, full, full!)
  - Users spread all over the world
- Set up methodology for remote sharing of other large scientific instruments.

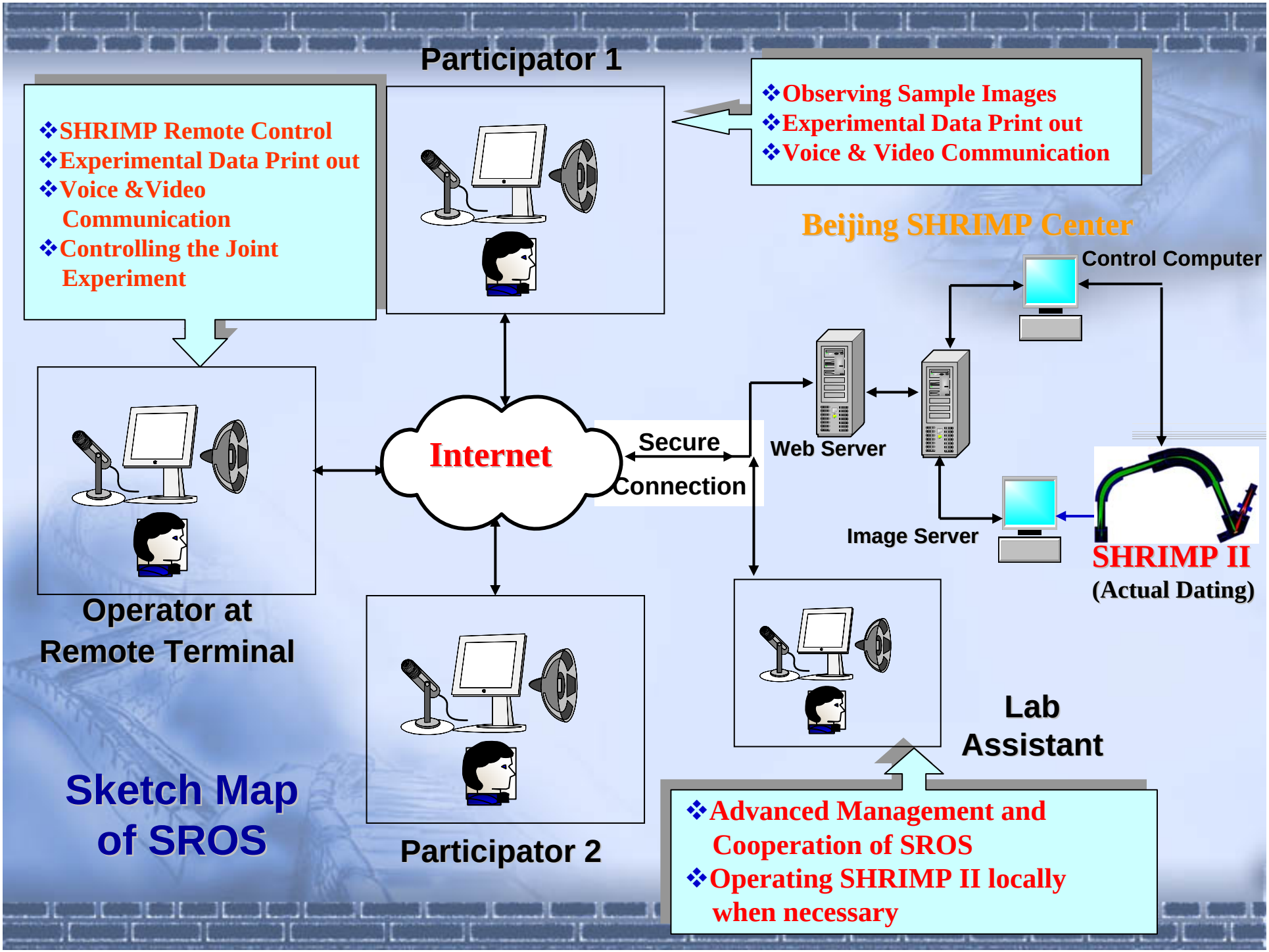
Functions of SROS

- Scientists can observe the samples, operate the SHRIMP and obtain analytical data online in real time.
- Support more scientists from different places participating in joint experiments and exchange ideas with each other through video and voice in real time.
- Online training for SHRIMP beginners.


VG710s
SAMSUNG
SyncMaster 192w

SHRIMP Remote Analysis Sequence




Participator 1
❖SHRIMP Remote Control
❖Experimental Data Print out
❖Voice &Video Communication
❖Controlling the Joint Experiment
❖Observing Sample Images
❖Experimental Data Print out
❖Voice & Video Communication
Beijing SHRIMP Center
Control Computer
Internet
Secure Connection
Web Server
Image Server
SHRIMP II
(Actual Dating)
Operator at Remote Terminal
Participator 2
Lab Assistant
❖Advanced Management and Cooperation of SROS
❖Operating SHRIMP II locally when necessary
Sketch Map of SROS

Yichang Institute of Geology and Mineral Resources

Hubei, China

August 10, 2005

Feedback from Yichang Workstation

User's Report

"**In general, SROS is stable and reliable as proved by the 2 days' remote operation** although there are some small problems to resolve. 11 zircon samples in two mounts of G1012 and G1013 for dating were fulfilled in this actual remote analysis and obtained the expected results. All samples analyzed were done by researchers from Yichang Institute of Geology and Mineral Resources at Yichang Workstation..."

University of São Paulo

Brazil

Sept.16th, 2005


20 6:15PM


20 6:15PM

Feedback from USP Workstation

The remote operation was a complete success !

User's report :

"On 19 and 20 September, the experiment was carried out and 80 U-Pb SHRIMP analyses (20 in standard zircon material, and 60 in unknown zircon grains) were carried out using the automatic protocol in use at the Beijing laboratory…

The performance of the software was at top level during the entire duration of the operation. Very seldom was there a necessity for calling the attention of the Chinese staff of the Beijing laboratory to make some small adjustments in situ in order to optimize the conditions of the measurements…

The entire operation was considered very successful. It was mentioned that, when a SHRIMP II instrument would be set up at the São Paulo laboratory, the SROS software could be operated locally or remotely, to strengthen the cooperative activities…"

Successful operation of the two SROS workstations has proven:

- Technology based on the internet for remote control and cooperative sharing of large scientific instruments is feasible.
- SHRIMP Remote Operation System has a high practical value.

SROS Analysis Done So Far

Aug 11-12, 2005	Yichang	48h
Sep 16-17, 2005	USP	28h
Nov 4-6, 2005	Yichang	72h
Mar 11-13, 2006	USP	72h
Mar 14, 2006	Yichang	10h
Jun 24-25, 2006	USP	48h
Dec 9-11, 2006	USP	72h
Apr 16-17, 2007	OGS	20h
Sep 15-17, 2007	USP	72h

Finally…

Internet has changed the life style for us and the way we work.

No doubt, it will bring a totally new way of conducting scientific research in the future.


Thanks for your attention !