Pioneering the Technique, Perfecting the Technology

ASI Presentation
Ed Roberts, CEO
Presentation to BGSW-08

- What's Happening with the SHRIMP
  - Technical updates
  - Automation
  - Remote access
  - SHRIMP SI
  - Double-dating
  - SQUID II

- Alphachron

- Collaboration & Developments

- Questions and Answers
SHRIMP Technical Updates

- Ongoing refinement of remote access capabilities – eg China, Goldschmidt
- Upgrades to optics manufacturability (with ANU Engineering / students)
- Upgrades to stages & encoders
- Deployment of advanced electrometers
- Use of dry-pumped systems
- Close-packed multi-collector heads for nuclear analysis, eg KBSI;
- Development of imaging detector capability – SIAS
- Labwindows now at version 8.5
SHRIMP Automation

- Developed at ANU for surveying Jack Hills zircons on SHRIMP I, 400 zircons per night;
- Uses LabView imaging capability;
- User defines spots on a jpeg image, system uses pattern recognition to locate zircons and area of the zircon;
- Image can be visible light, CL, BSE or other jpeg set;
- Retrofittable to all SHRIMPs, eg NIPR
- Overcomes need for ‘night runners’
SHRIMP Remote Access

- All SHRIMPs can be run in remote access mode, with existing or tailored software;
- Tailored software reduces hand-shaking when operating with long ping-times;
- Allows use within a building, checking from home (eg when running automation software), sharing within a local consortium, or selling machine time to overseas users (as done by CAGS);
- Also allows remote support including fault diagnosis and tuning from ASI;
- No extra charge for this capability.
SHRIMP SI Development

- Development headed by ANU, with funding and input from ASI (as part of a larger team);
- SHRIMP SI provides a development platform for a range of technologies & techniques, as described by Trevor;
- These will flow into SHRIMP IIe ongoing development;
- SHRIMP SI may be offered as a product in its own right, depending on user needs & interest.
- SHRIMP SI can undertake conventional Pb/U measurements, using duoplasmatron
ASI-CSIRO Collaboration

- Commonwealth Scientific and Industrial Research Organisation (CSIRO) is the national research body, with research in:
  - Division of Mineral Exploration and Mining (DEM)
  - Computation and Robotics
- ASI and CSIRO (DEM) delivering He-Th Thermochronology instruments (Alphachron);
- ASI and CSIRO cooperating on automated software for remote operation of instruments, based on NASA-sponsored research for lunar and Martian mining;

Alphachron Helium thermochronology Spectrometer, manufactured by ASI under Licence from the CSIRO
Alphachron

- Automated helium thermochronology instrument
- Uses diode laser to heat individual grains, guided by optical microscope and image recognition software
- Helium content determined with QMS, with $^3$He and $^4$He spike tanks
- Typically has 25 samples, processed overnight;
- Option of Quartz-Halogen step-heating of sample over days or weeks to determine closure temperature;
- Option of sampling bulk samples in vacuum furnace
- Software and some subsystem commonality with SHRIMP
- Recent installation at ASU
SHRIMP / Alphachron Double Dating

- Development of SHRIMP & Alphachron capabilities by CSIRO DEM (Brent McInnes) with Curtin SHRIMPs
- Measure U/Pb/Th with SHRIMP, then He with Alphachron – SHRIMPing has no impact on He measurement;
- Refinement of thermochronology measurement with X-Ray CAT Scan characterisation of mineral grain shape.
- This also allows detection of inclusions, fractures and voids.
ASI-GA Collaboration

- Geoscience Australia is the Australian Government national agency for geoscience research
- ASI and GA entered an agreement to share a SHRIMP Ile
- To facilitate further development of equipment, techniques and standards, with a key SHRIMP laboratory
- 4th SHRIMP in the ACT, with a 5th under construction (SHRIMP SI)
- Disassembly, transport, reassembly and pumping undertaken in one week
- In routine, 24-hour use for GA, ASI and visitors.
- Good source of design ideas for SHRIMP laboratory layout

GA SHRIMP Lab, with Federal Minister, Departmental Secretary, and Keith Sircombe.
SQUID II Software

- Developed in a consortium headed by Geoscience Australia
- Algorithms from Ken Ludwig (Berkley) via SQUID 1.
- Funding from SHRIMP Labs, GA, ASI
- Contributing labs have feedback into development, and early access to the code

Oxygen analysis of Neanderthal teeth (above) and conodonts (below)
Why Change SQUID 1?

• SQUID-1 is **inflexible**:  
  – Restricted minerals (Zrn-Bdl, Mnz, Ttn only)  
  – Run tables entirely predetermined (e.g. Zrn can’t use UO$_2$; Mnz must have ThO)

• SQUID-1 is **autocratic**:  
  – User input into processing limited/peripheral  
  – Output largely predetermined: additional calculations must be manual, sheet-by-sheet
SQUID-2 = SQUID-1 + flexibility

- Can parse any SHRIMP-generated .PD file; any mineral, any run table (user-defined)
- Customised data processing via user-defined equations using any Excel or Isoplot function:
  - Perform highly specialised calculations
  - Automate routine post-processing of data
- “Live” Excel charts with user-chosen axes
SQUID-2’s “engine”: the Task Editor
Customisation: User-defined equations
• Australian Nuclear Science and Technology Organisation (ANSTO) is Australia’s Government nuclear research body;
• ASI and ANSTO are working on development of next-generation IRMS mass spectrometers;
• ANSTO prepared representative samples of Pu/U for ASI/ANU to analyse in SHRIMP II and SHRIMP RG
• ANU and ANSTO have access to
  • Accelerator Mass Spectrometry (AMS),
  • SIMS
  • SHRIMP II,
  • SHRIMP RG and
  • Cameca 5f;
• TIMS, to characterise nuclear materials;
SHRIMP Workshops

- SHRIMP community runs regular workshops to facilitate exchange of techniques and ideas
- ASI sponsors these, and acquires valuable feedback and design ideas from customers
- Next workshop is in St Petersburg in June 2008
- Previously Canberra, Hiroshima, Perth
- Next in Korea (TBC) and Brisbane (TBC)
Summary

- Strong team of Customer-ASI-ANU
- Excellent SIMS instrument
- Depth of technical and scientific support
- Excellent scope for scientific collaboration between users and Australia
- Broad SHRIMP user community with common software tools (eg SQUID)
SHRIMP Utilisation

- Facilities schedule SHRIMP time in the same way as a large telescope, via a time assignment committee.
- Schedule users with instrument configuration (positive or negative mode).
- Remote access allows users to ‘visit’ the machine via the web (in the same way as modern telescopes are driven remotely).
- Facilities typically allocate part of the time on a commercial access basis: cost recovery.
Modular construction, simple geometry and computerised operation lead to high machine availability and productivity: e.g. China SHRIMP II

**Usage of SHRIMP II**

<table>
<thead>
<tr>
<th>Client</th>
<th>SHRIMP Running Time (Day)</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
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<tbody>
<tr>
<td></td>
<td>(1 machine day = 24h)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>CAS</td>
<td></td>
<td>50.5</td>
<td>58.5</td>
<td>56</td>
<td>63</td>
<td>58</td>
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<tr>
<td>Universities</td>
<td></td>
<td>45.5</td>
<td>63.5</td>
<td>86.5</td>
<td>51</td>
<td>58</td>
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<tr>
<td>MLR</td>
<td></td>
<td>95.5</td>
<td>93</td>
<td>151.5</td>
<td>149.5</td>
<td>126</td>
</tr>
<tr>
<td>Taiwan &amp; Hong Kong</td>
<td></td>
<td>21</td>
<td>14</td>
<td>6</td>
<td>9.5</td>
<td>13</td>
</tr>
<tr>
<td>Overseas</td>
<td></td>
<td>33</td>
<td>41</td>
<td>-</td>
<td>26</td>
<td>26</td>
</tr>
<tr>
<td>Others</td>
<td></td>
<td>-</td>
<td>1.5</td>
<td>1</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Total</td>
<td></td>
<td><strong>245.5</strong></td>
<td><strong>271.5</strong></td>
<td><strong>301</strong></td>
<td><strong>299</strong></td>
<td><strong>281</strong></td>
</tr>
</tbody>
</table>
SHRIMP II/Ile Operation

- Users experience very high reliability and availability, eg > 300 days per year of 24 hour access
- Users experience stable operation for long periods of time, eg “6 days of automated operation without even needing to adjust the oxygen flow”
- Users share SHRIMP time via remote operation and bureau services
- SHRIMPs are supported by remote access for tuning and diagnostics from the Australian team
- Each SHRIMP can support > 10 serious researchers full time, or their equivalent
- The SHRIMP requires about 25% of the time of a competent electronic technician for support. Experience on a modern mass spectrometer is a good starting point.
SHRIMP IIe/MC Running Costs

Expendable research materials $AUD

- 600 x 36 exposure films and film processing $10,900 (or equivalent colour laser printer consumables)
- 750mm x 1mm dia. 99.999% pure gold wire for coating of samples $5,350
- Helium line oil filter for cryocooler $1,500
- Computer paper and CDs/DVDs $1,050
- 5 Tantalum Köhler apertures and 2 Nickel cathodes $5,000
- 2 ETP electron multipliers (for on-axis detection) $3,600
- 10 Sjuts continuous dynode electron multipliers (for M/C heads) $15,000
- Cleaning $3,240
  - 1000 pairs disposable gloves,
  - 50 boxes tissue,
  - 200 litres Petroleum Spirit,
  - 52 litres ethyl alcohol
- Gas $1,050
  - 1 G size bottle high purity Helium,
  - 6 G size bottle Nitrogen,
  - 1 G size bottle medical grade Oxygen
- Electrical power 135,000 kWhrs @ $0.12/kWhr $16,200
- Labour costs in addition to those of an Operator (400 man hours @ $50.00/hr) $20,000

**TOTAL ESTIMATED ANNUAL RUNNING COST** $83,070
**TOTAL NON-LABOUR EXPENDABLES** $63,070
SHRIMP Delivery

- Lead time typically 18 months from order for standard machine, 22 months with multi-collector
- ASI does build continuously, so lead time can be less
- Installation takes about 6 weeks – ‘crates to dates’
- Facility needs to be set up in parallel. It has standard environmental requirements for a large instrument
- Facility requires overhead crane, air conditioning
- SHRIMPs are transported by air, about 10 crates, 16 tonnes
SHRIMP Support

- The SHRIMP IIe is a very reliable instrument providing excellent availability and ease of maintenance
- SHRIMP can be run, diagnosed and tuned remotely via a web interface
- SHRIMP is comparatively simple to repair, and spares are held in stock in Canberra
- Standard SHRIMP contract includes a comprehensive set of spares
- Three levels of support;
  - ASI – technical support by phone, e-mail, remote access (free) or site visits
  - ANU – ongoing support to the user community for development of techniques and underlying science
  - Potential for Local Support under a maintenance contract with local geochemist and ASI
SHRIMP Training

- Training in both scientific use and technical support of the SHRIMP is provided, by ASI and ANU personnel as part of the sales agreement.
- Training partly overlaps with the final phases of construction and testing, maximising familiarity with the instrument.
ASI-ANU Collaboration

- Sharing of staff, co-alignment of research, sharing of results for SHRIMP improvements
- ASI is a major contributor to the next-generation SHRIMP SI (Stable Isotope) machine
- Commercialisation of other ANU research
- Involvement of 4th year engineering students in Honors projects on SHRIMP
- ANU are the owners of ASI.
- ASI pays royalties to Research School of Earth Sciences