CAMECA®
SCIENCE & METROLOGY SOLUTIONS

AMETEK®

Rocks & Minerals



User Testimonials

Since we started to work with CAMECA IMS 1280 in 2008, we have developed U-(Th)-Pb dating procedures on more than ten kinds of accessory minerals to broaden understanding of in-situ geochronology. The good performance of this instrument made it feasible to date with as small as 2 micron-spot size. We bought the second one (IMS 1280-HR) in 2013 because of the increasing workload. These two instruments are serving a wide range of scientists worldwide.

Prof. Qiuli Li, Institute of geology and geophysics, Chinese Academy of Sciences, Beijing, China

CAMECA large-radius SIMS instruments define state of the art for in situ analysis of isotope ratios from the smallest possible spots. The WiscSIMS IMS 1280 routinely produces better precision and accuracy than previously imagined, enabling new areas of enquiry and discovery from paleoclimatology to zircons to meteoritics.

Prof. John Valley & Noriko Kita, University of Wisconsin, Madison, USA

The LEAP® has allowed us to see radioisotope geologic time in 3D for the first time. It is revolutionizing our view of natural materials, allowing us to use our macro-scale mapping approaches at the scale of the mineral lattice. It is an exciting time to be an Atom Probe geoscientist!

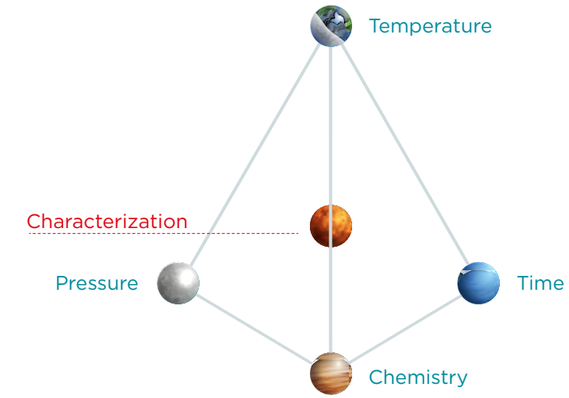
Prof. Desmond Moser, University of Western Ontario, USA

The CAMECA LEAP® with UV laser pulsing is a powerful tool for 3D nanoscale geochemistry studies. Its introduction just a few years ago has enabled the analysis of a broad range of geological materials, including ground-breaking imaging of sub-micron isotopic distributions. Since the Geoscience Atom Probe Facility was established at Curtin University in 2015, researchers from around the world have visited the facility to make use of the LEAP's capabilities, resulting in many new insights into geological processes active at the nanoscale.

Dr. David Saxey, Department of Physics and Astronomy & Curtin University, Perth, Western Australia

The Critical Role of Material Characterization

From natural gas to fossil oil trapped within rocks, from sand on the beach to diamonds, from extraterrestrial material to Earth, some of the fundamental questions about how materials were created rely on the study of geoscience. A subtle combination of pressure, temperature, time and chemistry is often at the base of our understanding. Through material characterization, scientists can discover how and when certain minerals and rocks were created, which can then point us toward the origin of our planet.

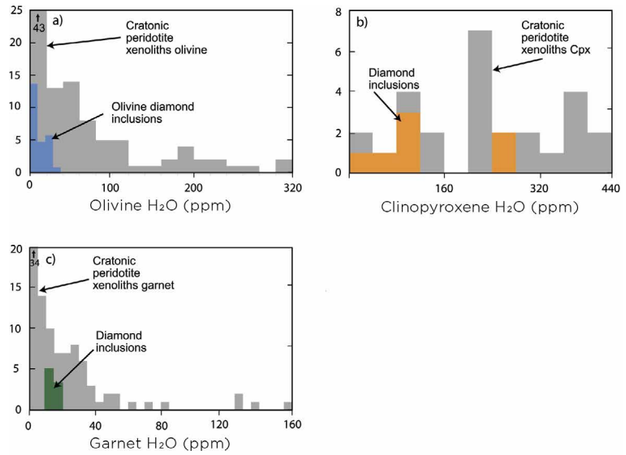


Isotope analysis is a key piece of the puzzle, enabling radiometric dating of rocks, characterization of extraterrestrial materials such as meteorites, or the study of key questions of climate change. Trace element distributions can be identified and quantified with a wide range of CAMECA instrumentation.

Past, Present and Future of our Planet

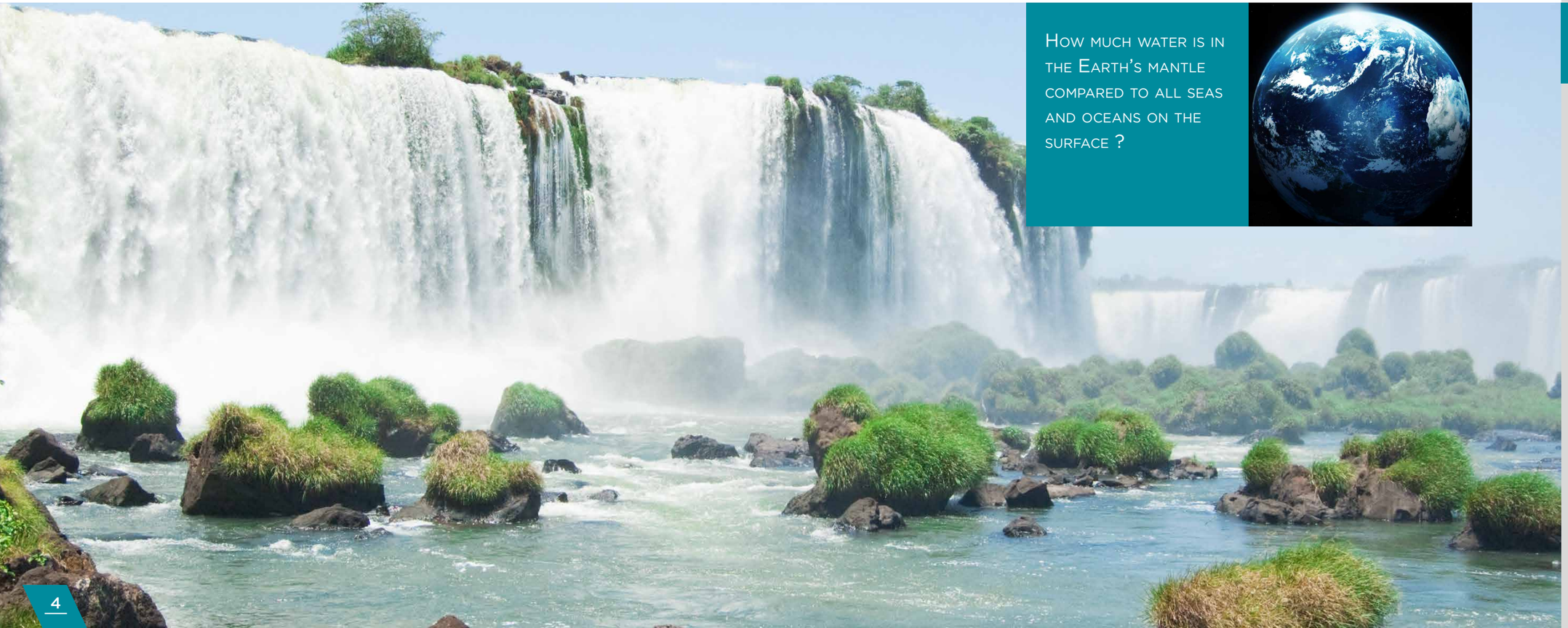
The Earth's mantle is the major reservoir of our water, in the form of hydrogen bonded to the silicate's structural oxygen. There are conflicting opinions regarding the 'water budget' of the Earth's mantle. How much water exists? How is it distributed? Where does it come from? These questions are subject to heated debates. Several approaches can be undertaken by analyzing mineral inclusions encapsulated at hundreds of kilometers depth within the mantle during diamond formation.

How can in-situ isotopic and elemental information from mineral samples help scientists reach an understanding? CAMECA has the answer.



Diamond-inclusion water concentrations for (a) olivine, (b) clinopyroxene, and (c) garnets, compared with data compiled for cratonic xenoliths from the Kaapvaal, Siberian, and Tanzanian cratons.

Data from: L. A. Taylor et al, Earth and Planetary Science Letters 433, 125–132 (2016).



How much water is in the Earth's mantle compared to all seas and oceans on the surface ?

SIMS

IMS 7f-GEO

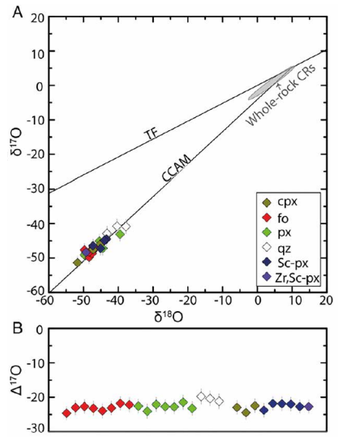


The **CAMECA IMS 7f-GEO** is a mono-collection SIMS model specifically designed to perform high precision & high throughput measurements in geological samples, i.e. stable isotopes and trace elements. High quality data and low detection limits are obtained for light elements due to its high-density primary bombardment, optimized vacuum and high mass resolving power capabilities.

Isotopic Compositions in Meteorites

Meteorites can provide essential information about our early solar system and how it has evolved into the solar system of today. Refractory inclusions in chondritric meteorites are of particular interest: they are the oldest solar system solids dated, and provide records of high-temperature processes in the early solar system. Scientists rely on very precise isotopic ratio analyses in these inclusions to shed light on the early evolution of the solar system.

How can scientists accurately and confidently determine isotopic variations between samples from different parts of our solar system? CAMECA has the answer.



From: M. Komatsu et al, PNAS 115, 7497-7502 (2018)

(A) Three-oxygen isotope ($\delta^{17}O$ vs. $\delta^{18}O$) diagram and (B) $\Delta^{17}O$ values of individual minerals from Y-793261 amoeboid olivine aggregates (AOA). All minerals in the AOA plot near the carbonaceous chondrite anhydrous mineral (CCAM) line and have ^{16}O-rich compositions ranging from −20 to −25‰ in $\Delta^{17}O$. The terrestrial fractionation (TF) line is shown for reference.

ISOTOPIC SIGNATURES IN PRESOLAR GRAINS CONTRIBUTE TO ADVANCES IN SPACE & EARLY EARTH RESEARCH.



SIMS

IMS 1300-HR³

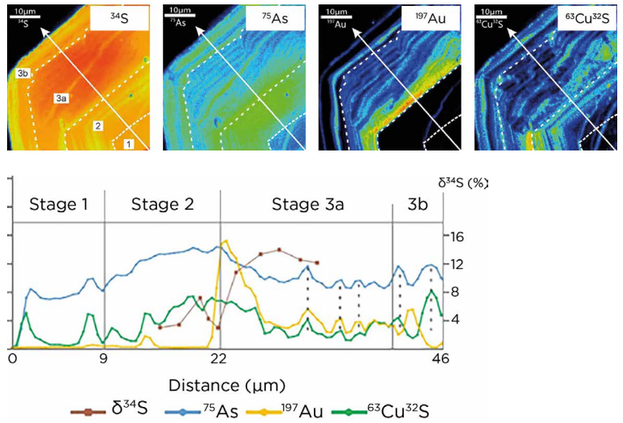


Due to its high density cesium ion bombardment and its isotopic multicollector system, the **CAMECA IMS 1300-HR³** ion microprobe enables rapid, high precision isotope analysis. Sample size is limited in extraterrestrial materials such as meteorites or particles. The **IMS 1300-HR³** allows the use of small spot sizes, from 10µm down to <1µm, in order to characterize isotope systematics at a fine scale.

Mining: Guiding Diggers through Data Analysis

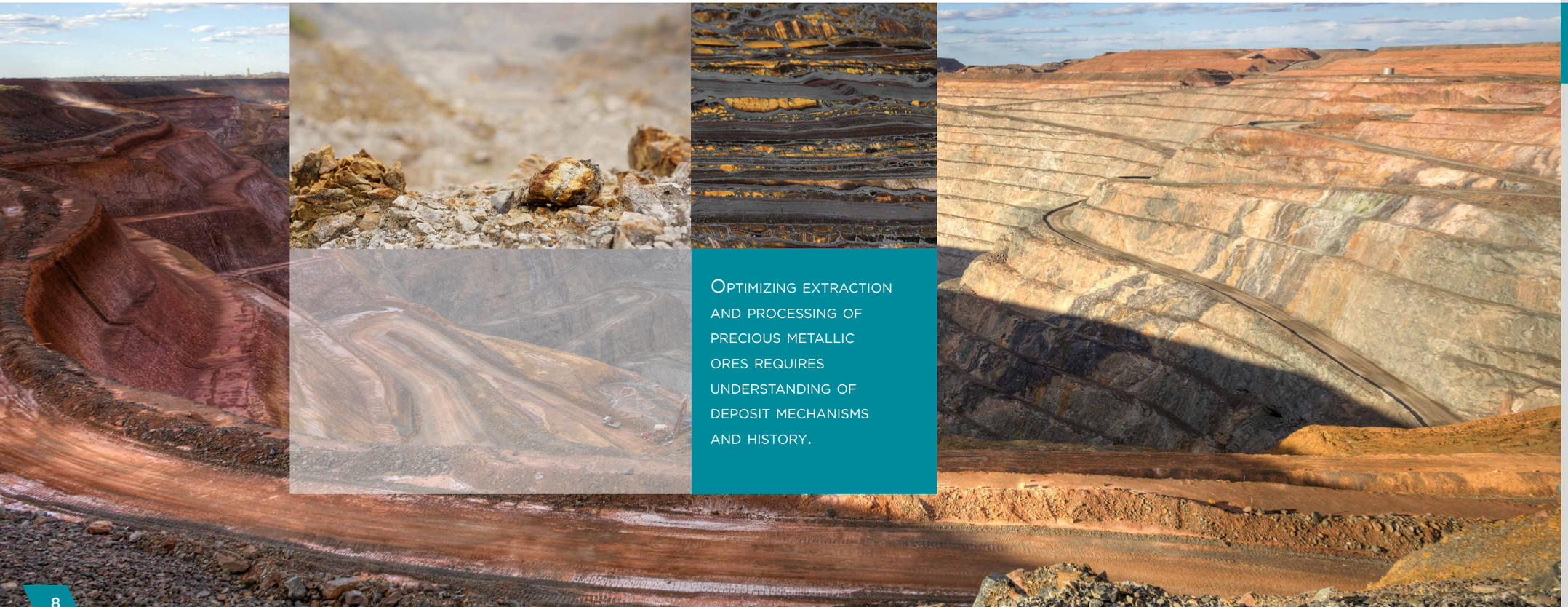
To compensate for the decrease in average gold ore quality over the last 20 years, the mining industry processes four times more ore to produce the same amount of gold. Knowing the microscopic details of the chemistry and gold distribution in ore is critical to maximizing profit. Innovative microanalysis techniques are essential to optimize discovery and extraction.

How can scientists help mining companies target the best locations for a better return on investment? CAMECA has the answer.



Representative pyrite from sample LNG3-1, Lannigou gold deposit. Three main stages can be distinguished by Au-As concentration and texture. 1, pre-ore stage equal to pyrite core forming; 2, As precipitated without Au; 3, main Au precipitation stage. Two period in stage 3 are divided by line scan character of gold and arsenic. White arrow: path of the line scan.

From: NanoSIMS element mapping and sulfur isotope analysis of Au-bearing pyrite from Lannigou Carlin-type Au deposit in SW China: New insights into the origin and evolution of Au-bearing fluids. Jun Yan et al. Ore Geology Reviews 92 (2018) 29–41.



OPTIMIZING EXTRACTION AND PROCESSING OF PRECIOUS METALLIC ORES REQUIRES UNDERSTANDING OF DEPOSIT MECHANISMS AND HISTORY.

SIMS

NanoSIMS 50L

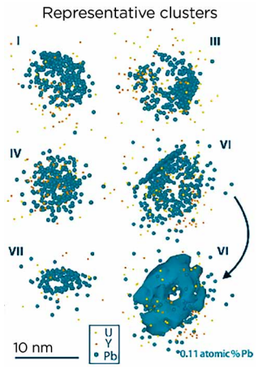


The **CAMECA NanoSIMS 50L** is a dynamic SIMS using a ~50nm spot size for both negative and positive secondary ions to produce high spatial resolution imaging capability. It has parallel detection of up to seven elements or isotopes and ultra-high sensitivity, combined with high mass resolving power and excellent lateral imaging resolution.

Nano-Geochronology of Zircon

When was the Earth formed? Rocks are the major building blocks of most ancient monuments and continue to be instrumental in architectural projects. On a deeper level, geological materials may hold the key to our past on Earth, and even to the origin of our solar system. Certain minerals are useful natural temporal systems because of the presence of elements (Pb, U, Th) with well-understood isotopic decay rates, often located in nanoclusters.

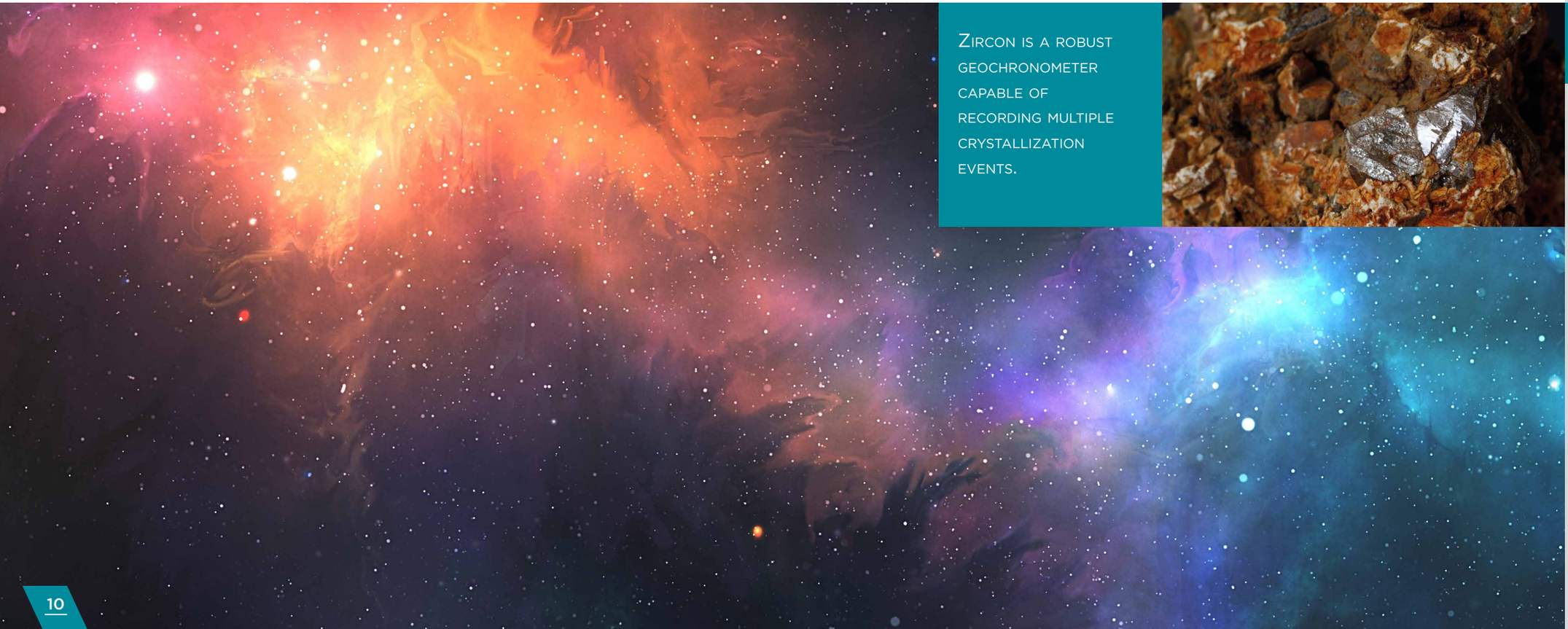
How can we provide accurate chemical identification and measure isotopic composition in nanoclusters in three dimensions? CAMECA has the answer.



Cluster	Pb counts (atoms)		Date (Ma) ±1σ
	^{206}Pb	^{207}Pb	
I	564	84	2334 ± 210
II	176	24	2151 ± 443
VIII	93	15	2456 ± 590
VI	900	142	2424 ± 163
III	786	107	2177 ± 221
IV	824	108	2111 ± 202
VII	126	17	2151 ± 515
V	87	11	2000 ± 713
Total	**3556**	**507**	**2258 ± 90**

Representative clusters from the discordant 2.1 Ga zircon. Clustered Pb (green) atoms are shown without co-clustering of U (yellow) atoms. Roman numerals correspond to the adjacent table of Pb isotope ratio analyses.

From: E.M. Peterman et al., Science Advances, 2 : e1601318 (2016).



ZIRCON IS A ROBUST GEOCHRONOMETER CAPABLE OF RECORDING MULTIPLE CRYSTALLIZATION EVENTS.

APT

LEAP® 6000 XR

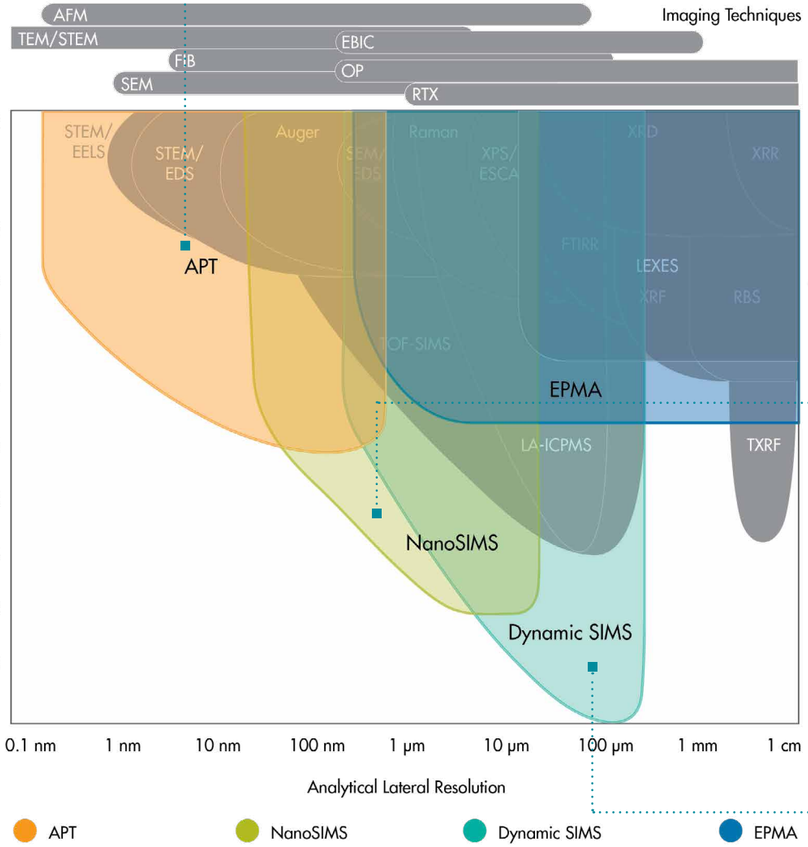


Atom Probe Tomography (APT) provides quantitative compositional analysis with sub-nanometer spatial resolution in three dimensions. It is especially suited for characterizing composition variations from microscale to sub-nanoscale.

- **EIKOS-UV™**, the Atom Probe for core APT applications;
- **LEAP® 6000 XR**, with a UV laser, enables high productivity and a wide variety of applications.

Broad Solutions to your Analytical Needs

CAMECA makes products tailored to the characterization of materials at all length scales, from millimeters to nanometers, and can provide a complete solution to your materials characterization challenges. From bulk composition with ppm sensitivy to nanometer scale atom clusters, you can find your characterization solution at CAMECA.





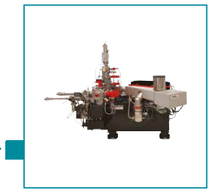
LEAP®
6000 XR



Invizo®
6000



EIKOS-UV™



NanoSIMS 50L



IMS
1300-HR³



IMS
7f-Auto

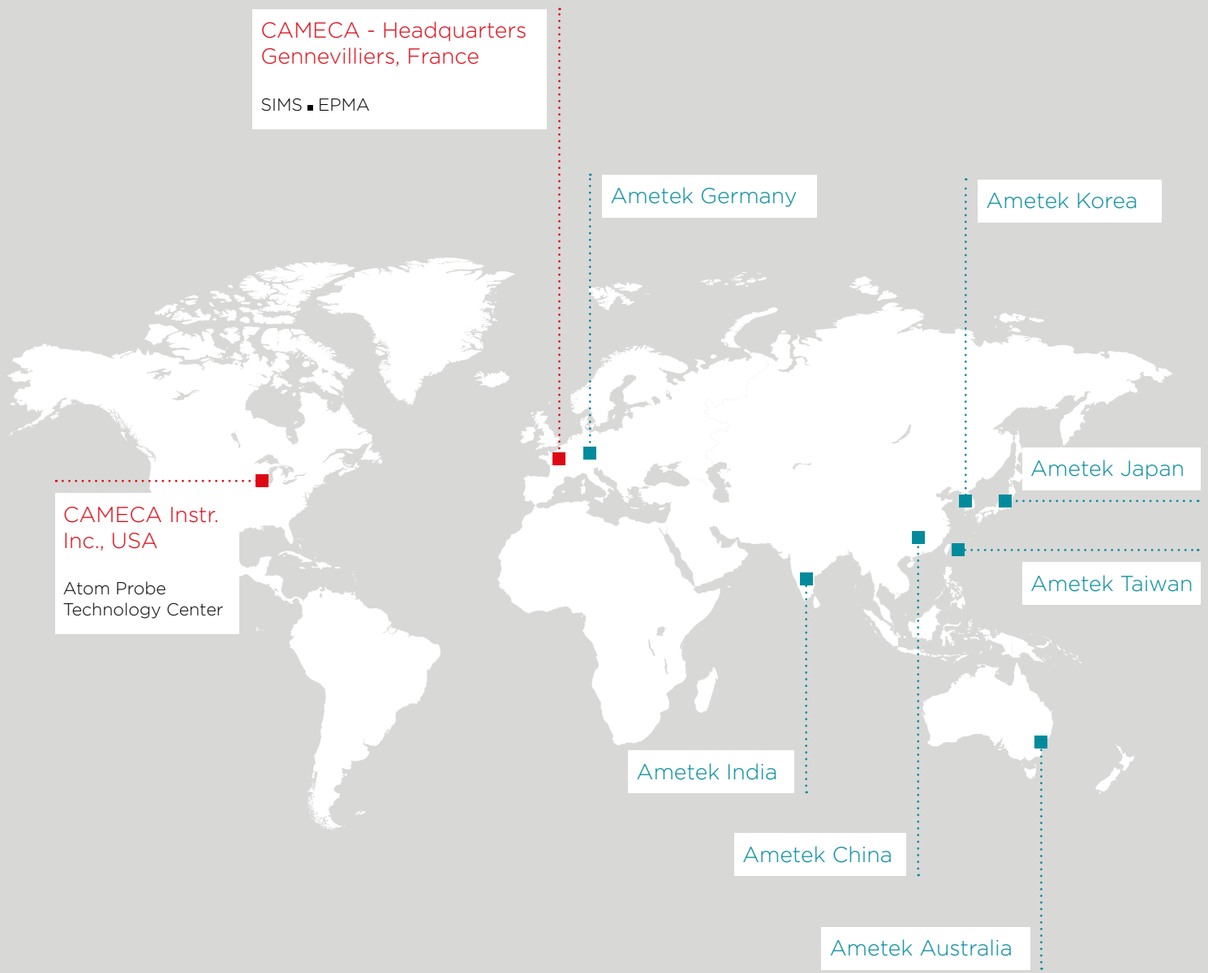
About CAMECA

CAMECA started in France in 1929 as a manufacturer of movie theater projectors, before rapidly evolving into a provider of scientific instrumentation for the international research community and in-fab / near-fab metrology solutions for the semiconductor manufacturing industry. From its inception, CAMECA has been renowned for its precision mechanics, optics and electronics.

Since pioneering Electron Probe MicroAnalysis (EPMA) in the 1950's and Secondary Ion Mass Spectrometry (SIMS) in the 1960's, CAMECA has remained the undisputed world leader in these techniques while achieving numerous breakthrough innovations in complementary techniques such as Low energy Electron induced X-ray Emission Spectrometry (LEXES), and Atom Probe Tomography (APT).

Operating under ISO 9001 certification, CAMECA controls not only the technology, but all aspects in the design, manufacture, installation, and servicing of products. Located near Paris, France (CAMECA headquarters) as well as in Madison, Wisconsin, USA, our plants are state of the art facilities, using best practices for clean room production, computer networking, electron and ion optics simulation, and advanced CAD.

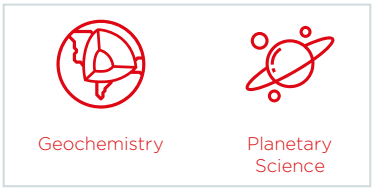
CAMECA is a business unit of AMETEK, Inc., a leading global provider of electronic instruments and electromechanical devices, as part of the AMETEK Materials Analysis Division.



R&D and production center, Sales and service

Sales and service

World Leader in Elemental & Isotopic Microanalysis





CAMECA (Corporate Headquarters)
29 Quai des Grésillons
92622 Gennevilliers - France
Tel: +33 1 43 34 62 00
cameca.info@ametek.com

CAMECA Atom Probe Technology Center
5470 Nobel Drive
Madison WI 53711 - USA
Tel: +1 608 274 6880

WORLD PREMIER PROVIDER OF SCIENCE & METROLOGY SOLUTIONS FOR ELEMENTAL & ISOTOPIC MICROANALYSIS.
WE DELIVER CUTTING-EDGE SCIENCE AND METROLOGY SOLUTIONS, AND OFFER OUR CUSTOMERS UNPARALLELED SUPPORT AND MAINTENANCE SERVICE THROUGH THE COMPREHENSIVE AMECARE PERFORMANCE SERVICES PROGRAM.

www.cameca.com

MKB-GEO-1 - Non-contractual document. CAMECA reserves the right to alter the specifications of its products without notice. All mentioned trademarks are registered by their respective owners.

CAMECA® SCIENCE & METROLOGY SOLUTIONS / AMETEK®