THE UNIVERSITY OF HAWAII IMS 1280 ION MICROPROBE. G. R. Huss[1], K. Nagashima[1], K. Keil[1], A. N. Krot[1], G. J. Taylor[1] and E. R. D. Scott[1], [1]Hawaii Institute of Geophysics and Planetology, University of Hawaii at Manoa, 1680 East-West Road, Honolulu, HI 96822, USA (ghuss@higp.hawaii.edu).

Introduction: In March, 2006, the Hawaii Institute of Geophysics and Planetology expects to take delivery of a new Cameca ims 1280 ion microprobe. The new ion probe will be the centerpiece of the W. M. Keck Cosmochemistry Laboratory and will be used to analyze extraterrestrial materials, including meteorites, interplanetary dust particles (IDPs), and samples returned by NASA missions. The 1280 is the newest incarnation of the large-geometry Cameca ion probe [1]. It uses a new generation of electronics to control the voltages in the primary-ion column and secondary-ion mass spectrometer. It has improved magnet control, including an improved Hall probe system and a new NMR system. It has computer control of all slits and apertures, new computer routines to improve reproducibility, and improved ion detectors. These new features give the 1280 better performance than earlier machines. For example, the 1280 can measure oxygen isotopic compositions of mineral grains at a spatial scale of ~25 microns with a precision and reproducibility of <0.5 permil (2σ) [2].

We will upgrade this highly capable instrument with additional state-of-the-art technologies to address the unique challenges of research on early solar-system materials. We will add a secondary-electron detector to aid in locating tiny grains for analysis. The secondary-electron image in the ion microprobe can be directly correlated with the secondary-electron image from an SEM. To help precisely position the sample under the primary beam during automated analyses and to facilitate using sample locations determined by an automated system on the SEM, we will add optical encoders to the sample stage. In collaboration with Prof. Yurimoto of Hokkaido University, we will add a new type of two-dimensional, solid-state detector called SCAPS [3, 4]. Dr. Nagashima, a member of our research team, is a co-developer of this unique detector. The SCAPS detector will permit direct ion imaging of fine-grained samples and will permit identification of isotopically or chemically anomalous grains at a spatial resolution of a few tenths of a micron [e.g., 5, 6]. Direct imaging uses the mass spectrometer as an ion microscope and can use either a rastered or a defocused beam. The spatial resolution is controlled by either the ion optics of the mass spectrometer or the pixel size of the detector. In contrast, NanoSIMS uses scanning ion imaging combined and multiple ion collectors (the 1280 also has this capability). The beam is rastered over the sample and data for several isotopes are collected by the multi-collection electron multipliers. Ion images are reconstructed by the computer. The spatial resolution is controlled by the probe size of primary-ion beam.

We will use the highly versatile UH 1280 for several types of studies of extra-terrestrial materials. A major research area will be isotopic studies of presolar grains, IDPs, and samples returned by the Stardust Mission. The goals of these studies are to understand the raw material from which the solar system formed and to investigate the details of stellar nucleosynthesis [e.g., 5-7]. The high sensitivity and mass resolving power of the 1280 combined with the secondary electron detector, multi-collector detector system, and ion imaging using the SCAPS detector will make the 1280 competitive with NanoSIMS in many respects.

Another major research area will be studies of short-lived radionuclides, such as ^{10}Be, ^{26}Al, ^{41}Ca, ^{36}Cl, ^{53}Mn, and ^{60}Fe. These nuclides can provide high-resolution chronometers for events in the early solar system. They also provide constraints on the last contribution of newly synthesized elements to the early solar systems and on the irradiation environments where various objects formed [e.g., 8, 9]. The 1280 is particularly advantageous for studying ^{41}Ca, ^{36}Cl, ^{53}Mn and ^{60}Fe because of its high sensitivity at high mass resolving power.

A hot area of research in cosmochemistry is the study of oxygen isotopes. Non-mass-dependent isotopic effects in oxygen are used to classify meteorites, and oxygen compositions differ significantly among the components of chondrites [10]. However, we still do not understand how these effects originate. Do they result from incomplete mixing of nucleosynthetic components, from self-shielding in the nebular gas, from chemical effects of irradiation of symmetric molecules, or is there another origin [e.g., 11]? The ability of the 1280 to make high-precision oxygen isotopic measurements at a fine spatial scale while keeping the petrographic context intact will give us a powerful tool to investigate these questions.

Studies of trace elements in chondritic components and differentiated meteorites give information about the conditions under which they formed. For example, trace elements in CAIs provide information about the process by which the CAI formed, source material, and oxygen fugacity in the formation region [e.g., 12]. Trace-element profiles can also provide information about the cooling history of an object [e.g., 13]. The high sensitivity at high mass resolving power of the 1280 may permit development of a high-resolution method for measuring trace elements (as opposed to energy filtering). Higher sensitivity compared to energy filtering and better elimination of molecular interferences are potential advantages of such a technique.

We will also work on developing protocols for measuring isotopic compositions of new elements. The UH 1280 should have a useful mass resolving power of ~25,000 (10% definition), which will permit measurements of elements that were not previously accessible by ion probe. Technology development will also be a part of our work. The new SCAPS detector is a functional analytical device, but the technology upon which it is based is still in its infancy. In collaboration with Hokkaido University, we will work toward the next generation of this detector, which some day may replace not only the conventional ion-imaging systems but also the current Faraday-cup and electron-multiplier detectors.

A modern, automated analytical instrument can generate a huge amount of data in a short time, more data than our research group will be able to effectively handle. We therefore encourage collaborative research in cosmochemistry and will make time available to outside researchers. A laboratory like this is expensive to operate and maintain, and improving the state of the art is even more expensive. Our laboratory will be funded in large part by user fees paid by individual researchers. UH researchers include user fees as a line item in their research grants. We also plan to generate additional funds for instrument development. Contact us for information about doing your analyses at the University of Hawaii.

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Fig. 1: Image of the partially constructed UH ims 1280 in the Cameca factory in Paris taken in August, 2005.

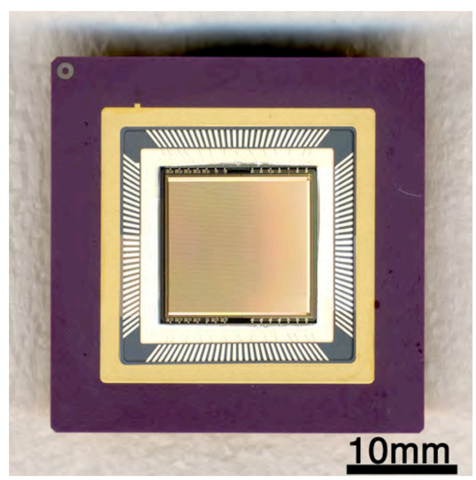

Fig. 2: The SCAPS detector developed by Drs. Yurimoto, Nagashima, and colleagues [3, 4] will be installed in the UH ims 1280 ion probe.