5) *Preliminary sample characterization provides data that supports smart decisions during mission operations.* Data supports sample prioritization, enables a better understanding of the regional geology being explored, highlights details on samples, and is useful for future exploration plans. The types of data that were collected in the GeoLab during the analog tests allow for wide dissemination and broad participation by scientists and students on Earth.

## Dividing the Concentrator Target From the Genesis Mission

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The Genesis spacecraft, launched in 2001, traveled to a Lagrangian point between the Earth and Sun to collect particles from the solar wind and return them to Earth. However, during the return of the spacecraft in 2004, the parachute failed to open during descent, and the Genesis spacecraft crashed into the Utah desert. Many of the solar wind collectors were broken into smaller pieces, and the field team rapidly collected the capsule and collector pieces for later assessment. On each of the next few days, the team discovered that various collectors had survived intact, including three of four concentrator targets. Within a month, the team had imaged more than 10,000 fragments and packed them for transport to the Astromaterials Acquisition and Curation Office within the ARES Directorate at JSC. Currently, the Genesis samples are curated along with the other extraterrestrial sample collections within ARES.

Although they were broken and dirty, the Genesis solar wind collectors still offered the science community the opportunity to better understand our Sun and the solar system as a whole. One of the more highly prized concentrator collectors survived the crash almost completely intact (figure 1). The Genesis Concentrator was designed to concentrate the solar wind by a factor of at least 20 so that solar oxygen and nitrogen isotopes could be measured.

One of these materials was the Diamond-on-Silicon (DoS) concentrator target. Unfortunately, the DoS concentrator broke on impact (figure 1). Nevertheless, the scientific value of the DoS concentrator target was high. The Genesis Allocation Committee received a request for ~1 $cm^2$ of the DoS specimen taken near the focal point of the concentrator for the analysis of solar wind nitrogen isotopes. The largest fragment, Genesis sample 60000, was designated for this allocation and needed to be precisely cut. The requirement was to subdivide the designated sample in a manner that prevented contamination of the sample and minimized the risk of losing or breaking the precious requested sample fragment.

The Genesis curator determined that the use of laser scribing techniques to “cut” a precise line and subsequently cleave the sample (in a controlled break of the sample along that line) was the best method for accomplishing the sample subdivision. However, there were risks, including excess heating of the sample, that could cause some of the implanted solar wind to be lost via thermal diffusion. Accidentally breaking the sample during the handling and cleaving process was an additional risk. Early in fiscal year 2013, to address this delicate, complicated task, the ARES Directorate assembled its top scientists to develop a cutting plan that would ensure success when applied to the actual concentrator target wafer; *i.e.*, to produce an approximately 1 $cm^2$ piece from the requested area of the wafer. The team, subsequently referred to as the JSC Genesis Tiger Team, spent months researching and testing parameters and techniques related to scribing, cleaving, transporting, handling, and holding (*i.e.*, mounting) the specimen. The investigation required considerable "thinking outside the box," and many, many trials using nonflight wafer analogs.

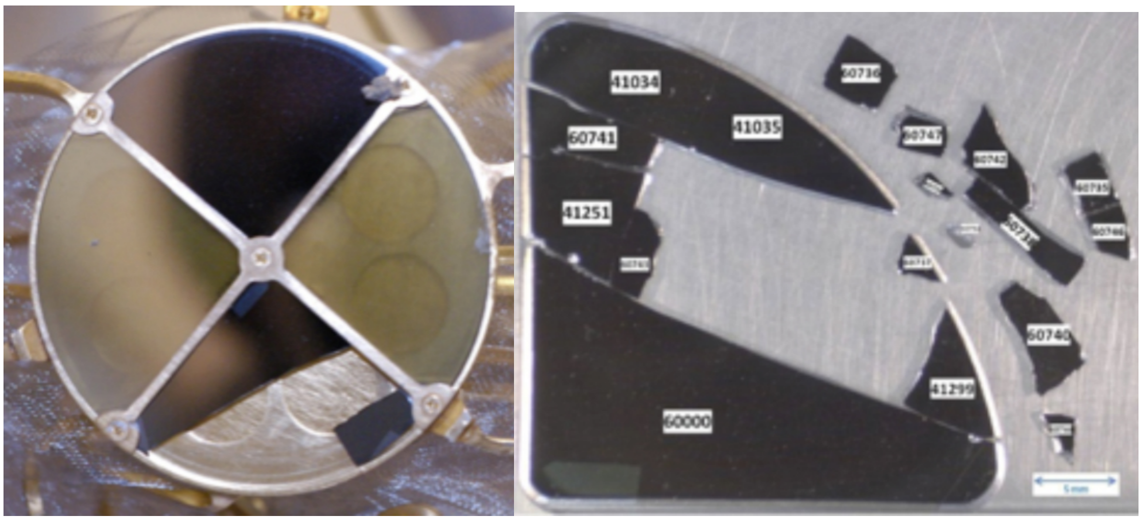


*Figure 1.– Genesis Concentrator target (left) and the recovered DoS fragments (right).*

After all preliminary testing, the following method was adopted as the final cutting plan. It was used in two final end-to-end practice runs before being used on the actual flight target wafer. The wafer was oriented on the laser cutting stage with the 100 and 010 directions of the wafer parallel to the corresponding X and Y directions of the cutting stage. The laser was programed to scribe 31 lines of the appropriate length along the Y stage direction. The programed scribe lines were separated by 5 µm in the X direction. The laser parameters were set as follows: (1) The laser power was 0.5 watts; (2) each line consisted of 50 passes, with the Z position being advanced 5 µm per pass; and (3) 30 s would elapse before the next line was scribed to allow for wafer cool down from any possible heating via the laser.

The ablated material that "stuck" in the "scribe-cut" was removed from the "cut" using an ultrasonic micro-tool. After all the ablated silicon was removed from the wafer, the wafer was repositioned in exactly the same orientation on the laser stage. The laser was focused using the bottom of the wafer channel, and the 31-line scribing pattern described above was reprogrammed using the Z position of the groove bottom as the starting Z value instead of the top wafer surface, which was used previously. Upon completion of the second set of scribes, the ultrasonic micro-tool was again used to clean out the cut. The wafer was remounted on the stage in exactly the same orientation as before. The laser was again focused on the bottom of the groove. This time, however, the laser was programed to scribe only one line down the exact center of the channel. The final scribe line consisted of 100 passes with a Z advance of 5 µm per pass and with the laser power set at 0.5 watts. As mentioned above, the final cutting plan was practiced in two end-to-end trials using nonflight, triangular-shaped silicon wafers similar in size and orientation to the actual DOS 60000 target sample. The actual scribing of the triangular-shaped wafers required scribing two lines and cleaving (*i.e.* scribe-cleave, then scribe-cleave) to obtain the piece requested for allocation.

Early in December 2012, after many months of experiments and practicing and perfecting the techniques and procedures, the team successfully subdivided the Genesis DoS 60000 target sample, one of the most scientifically important samples from the Genesis mission (figure 2). On December 17, 2012, the allocated piece of concentrator target sample was delivered to the requesting principal investigator.

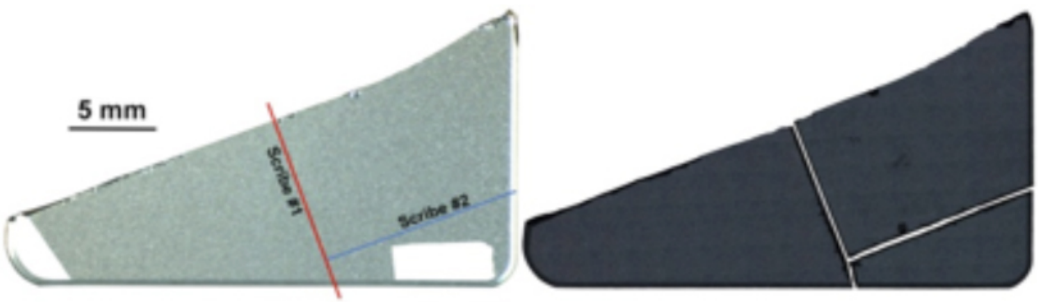


*Figure 2.– Left – Image of the back side of the DoS 60000 wafer with the location of the two proposed scribing lines projected onto the surface. Right – The actual flight specimen following successful processing by the JSC Genesis Tiger Team.*

The cutting plan developed for the subdivision of this sample will be used as the model for subdividing future requested Genesis flight wafers (appropriately modified for different wafer types).

## *The Apollo Lunar Sample Image Collection: Digital Archiving and Online Access*

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The primary goal of the Apollo Program was to land human beings on the Moon and bring them safely back to Earth. This goal was achieved during six missions – Apollo 11, 12, 14, 15, 16, and 17 – that took place between 1969 and 1972. Among the many noteworthy engineering and scientific accomplishments of these missions, perhaps the most important in terms of scientific impact was the return of 382 kg (842 lb) of lunar rocks, core samples, pebbles, sand, and dust from the lunar surface to Earth. Returned samples were curated at JSC (then known as the Manned Spacecraft Center) and,