physical and chemical properties of a planet's surface. A mixture that was developed for engineers to drive rovers in would probably be terrible for studying the geochemical properties of the Moon.

Researchers do not always pay attention to those limitations, says Clive Neal, a lunar scientist at the University of Notre Dame in Indiana. "We have no accreditation in terms of what this can be used for and what it can't be used for," he says. "If you use it for the wrong thing you end up with misleading results."

In 2010, a panel of lunar scientists recommended that NASA develop a database that researchers could use to compare the characteristics of different simulants and pick the best one for each use. But the agency had no money to support such a project. The new working group aims to outline how much it would cost to produce a database covering simulants for all types of planetary body. "Hopefully, we'll be able to develop this repository," says Brad Bailey, associate director of NASA's Solar System Exploration Research Virtual Institute, who is based in Washington DC.

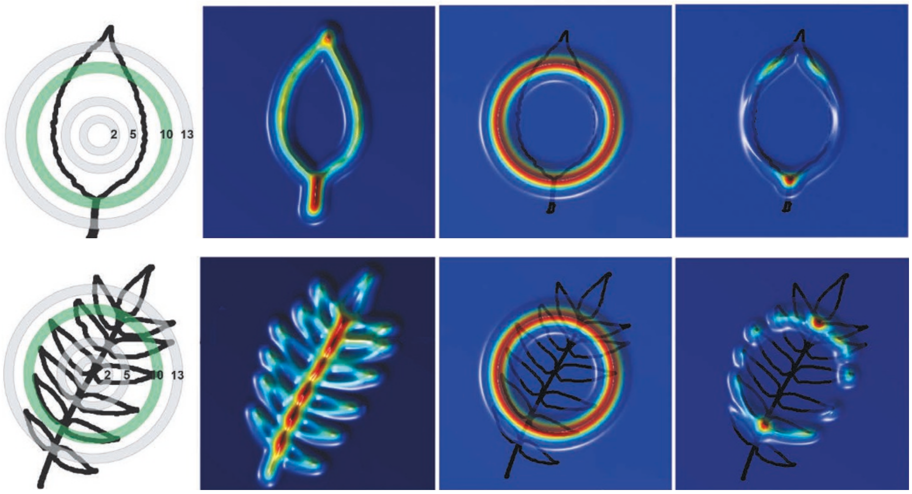
The database would include the four new asteroid simulants being made by the Orlando office of Deep Space Industries, an asteroid-mining company. NASA has ordered five tonnes for delivery over the next two years. Each simulant is based on a different class of meteorites called carbonaceous chondrites, which are thought to be chunks of asteroids.

SECRET RECIPE

To make fake asteroid dirt, technicians mix various minerals — including bronzite, which is sourced from jewellery suppliers as polished stones — compress them into bricks and then pulverize them. "We have to do something that is basically equivalent to hitting a solid rock with thousands of meteorites over a long period of time," says Stephen Covey, the company's director of research and development.

Deep Space Industries delivered 512 kilograms of the first simulant to NASA in March, and 532 kilograms of the second type in June. The agency plans to use the simulants in work on missions such as OSIRIS-REx, a spacecraft that is making its way to an asteroid to collect a sample and bring it back to Earth.

In Europe, Carpenter and his colleagues are still hunting for their perfect lunar soil — but they have given up on ordering it commercially. The researchers, who need 700 tonnes for a planned lunar habitat at ESA's astronaut-training centre in Cologne, Germany, are looking much closer to home. They have decided to grind up rocks from the nearby basalt mines of the Eifel region. ■



To compare leaf shapes, scientists assign values to pixels in an image and analyse them for patterns.

PLANT BIOLOGY

Atlas traces shape of 182,000 leaves

The data can be used to examine geographic and taxonomic relationships between species.

BY HEIDI LEDFORD

The story of a plant is etched in its leaves. A tree in a cold environment with plenty of water is likely to have large leaves edged with many serrated teeth. But if the same species lives in a warm, dry region, its leaves are more likely to be smaller and smoother.

Now, an atlas that traces the shapes of 182,000 leaves from 141 plant families in 75 locations around the world shows promise for refining scientists' ability to read that story. Using the atlas, researchers found that leaf shape alone accurately predicted where a leaf was collected 14.5% of the time, and plant family correctly 27.3% of the time (M. Li *et al.* Preprint at bioRxiv http://doi.org/b9gj; 2017). That is much better than predictions made using conventional methods.

Researchers hope that the approach will help them to learn more about the forces that shape plant leaves, and even to get a glimpse of ancient climates by analysing the shapes of fossilized plants. "It's an amazing data set," says Dan Peppe, a palaeobotanist at Baylor University in Waco, Texas. "We're getting closer and closer to automating measures of leaf shape, and using that to figure out the taxonomy of a plant and reconstruct climate."

The results were posted on 20 June to bioRxiv, a server that hosts biology preprints. Plant morphologist and lead author Dan Chitwood also presented the study at the Botany 2017 meeting in Fort Worth, Texas, on 27 June.

Chitwood, formerly of the Donald Danforth Plant Science Center in St Louis, Missouri, and his colleagues used a topological method called persistent homology to analyse the shape of each leaf. The method assigns each pixel in an image a value according to the density of the pixels around it. The researchers broke each leaf into 16 parts, and analysed the pattern of values in each one. Then they used the resulting catalogue of leaf shapes to look for taxonomic and geographic relationships.

Others are eager to apply the method to their own research. Plant morphologist Yannick Städler of the University of Vienna wants to use the technique to analyse X-ray images of flowers. He hopes that it will help him to overcome a stumbling block with conventional morphological methods, many of which involve placing landmarks — points on structures that recur across species — on images.

Those techniques work well for animals, he says, which tend to have obvious landmarks: the point at which two bones meet, the corner of an eye, the tip of a nose. But flowers often have smooth, curved surfaces, which makes it difficult to pinpoint specific landmarks. "This has been a horrible problem in leaves and in flowers," Städler says. "It has held us back." ■

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