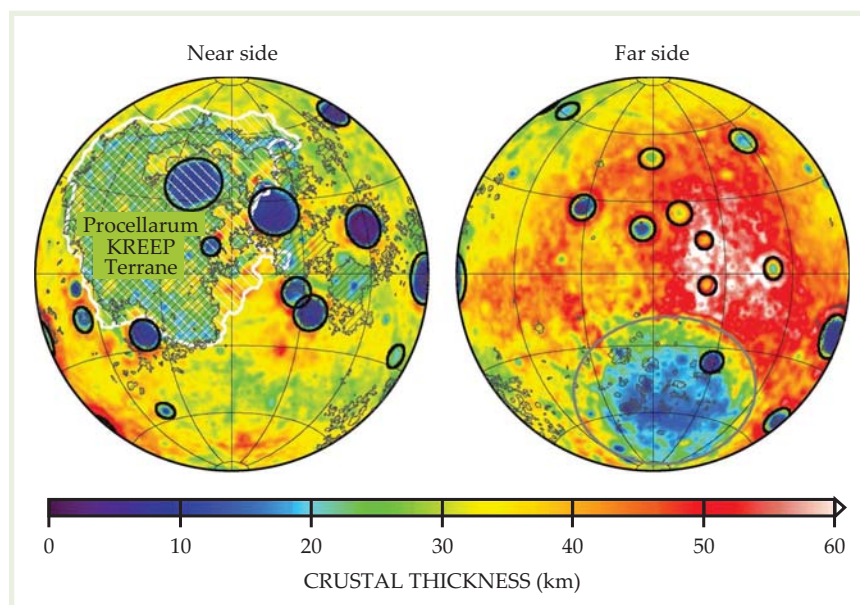


asymmetry in the thickness data: Eight basins on the Moon's near side (left panel) had diameters greater than 320 km, compared with just one of that size on the far side (right panel). That skewed distribution, they realized, has just a 2% chance of occurring given a uniform cratering rate.

Looking for the cause, Miljković has now run computer simulations to model the impact basins.² She, Wieczorek, and their coworkers found that two key and possibly related aspects were likely to influence basin formation. The GRAIL data had shown that the Moon's crust is far thinner on the near side—roughly 30 km thinner on average—than the far side's highlands. No one knows why. The near side is also rich in heat-producing radioactive elements, such as potassium, rare-earth elements, and phosphorus (collectively known as KREEP), a feature long known from the Apollo missions and later remote gamma-ray spectrometry but whose origin is also not well understood.

More than 99% of the Moon's exposed lavas erupted on the near side, and thermal evolution models suggest that the deep crust and mantle on the near side were probably warmer, possibly by several hundred kelvin during the late heavy bombardment, than on the far side.

Miljković tested how two different cases—a hot, thin crust and a cold, thick one—react to shock waves from a massive asteroid smashing into the Moon at nearly 20 km/s. According to her simulations, such impacts excavate the same amount of material in both cases. But the shear strength of the crust, thick or thin, is strongly dependent on temperature: Warmer crust is softer and more fluid than cold crust and requires less



A global map of the Moon's crustal thickness, derived from the gravity field data measured during NASA's GRAIL (Gravity Recovery and Interior Laboratory) mission, reveals 12 impact basins (circled in black) with diameters greater than 200 km on each hemisphere. That number excludes the far side's South Pole–Aitken basin (circled in gray), thought to have formed during a much earlier epoch than the other basins. The near side is dominated by the Procellarum KREEP Terrane (outlined in white), which contains high abundances of heat-producing potassium, rare-earth elements, and phosphorus. (Adapted from ref. 2.)

energy to melt. Moreover, the shock wave penetrates farther from a basin's center, and material well beyond the edge of the excavated cavity gives way as the mantle uplifts. The result is a basin whose width is nearly double what it would be in cold, thick crust. (See the online version of this report for a video.)

Astronomers have typically based their estimates of the sizes of ancient asteroids on near-side crater widths. That overestimates the mass flux from the asteroids by up to a factor of about

eight, but it's not likely to alter our view of the late heavy bombardment, says Miljković, beyond making the impacts less catastrophic. Nonetheless, the temperature- and thickness-dependent nature of the way basins form may bear on the proper interpretation of their size distribution on Mercury, Venus, and Mars.

Mark Wilson

References

1. M. Wieczorek et al., *Science* **339**, 671 (2013).
2. K. Miljković et al., *Science* **342**, 724 (2013).

physics update

These items, with supplementary material, first appeared at <http://www.physicstoday.org>.

En route to an amyloid fibril. Among the villains in human diseases are amyloid fibrils, long and tough structures that self-assemble from misfolded proteins (see *PHYSICS TODAY*, June 2013, page 16). Unraveling the actual assembly process is becoming increasingly important as research shows that some so-called intermediates—small structures that arise and then vanish during the assembly—have a large impact on the ensuing disease. But the transience of those intermediates makes them difficult to study. A team led by Martin Zanni of the University of Wisconsin has now used rapid-scan two-dimensional IR spectroscopy to watch amylin peptides as they aggregate into fibrils that are implicated in type-2 diabetes.

(For more on multidimensional spectroscopy, see the article by Steven Cundiff and Shaul Mukamel, *PHYSICS TODAY*, July 2013, page 44.) One element of all fibrils is the β sheet, an adjacent stacking of short strings of peptides known as β strands. The researchers found that a specific portion of the peptide forms a temporary parallel β -sheet structure before breaking into the disordered loop of the fiber. The team confirmed the presence of that intermediate with other experiments and with molecular dynamics simulations. The observation helps explain the previously known importance of that particular sequence in the peptide to diabetes development. It also explains the so-called lag phase, when toxic intermediates are present prior to fibril assembly: The intermediates seem to form a free-energy barrier that the reactants must then surmount in order to proceed with forming a fibril. (L. E. Buchanan et al., *Proc. Nat. Acad. Sci. USA* **110**, 19285, 2013.) —SGB