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SKY & TELESCOPE

THE ESSENTIAL GUIDE TO ASTRONOMY

DECEMBER 2024

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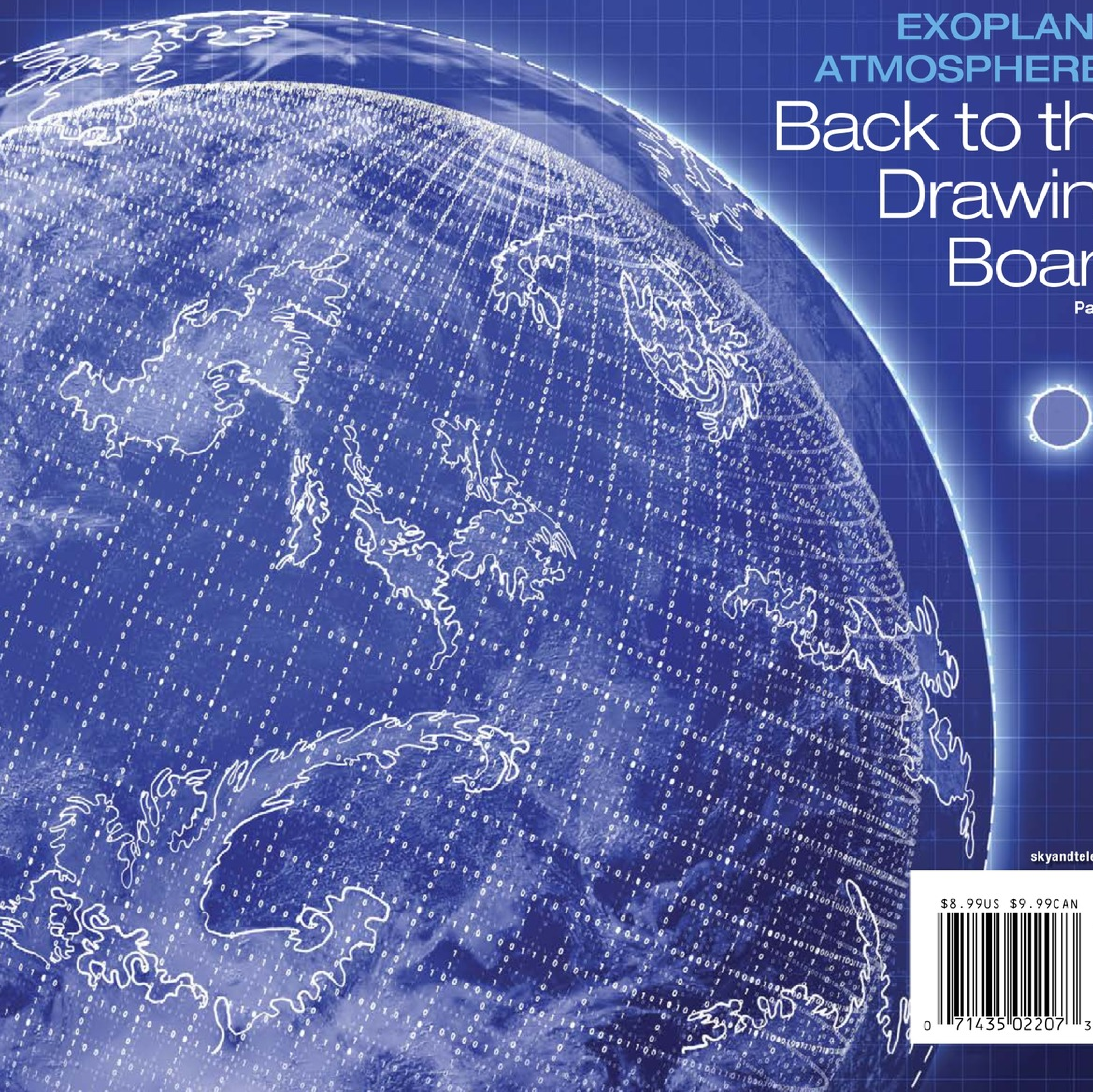

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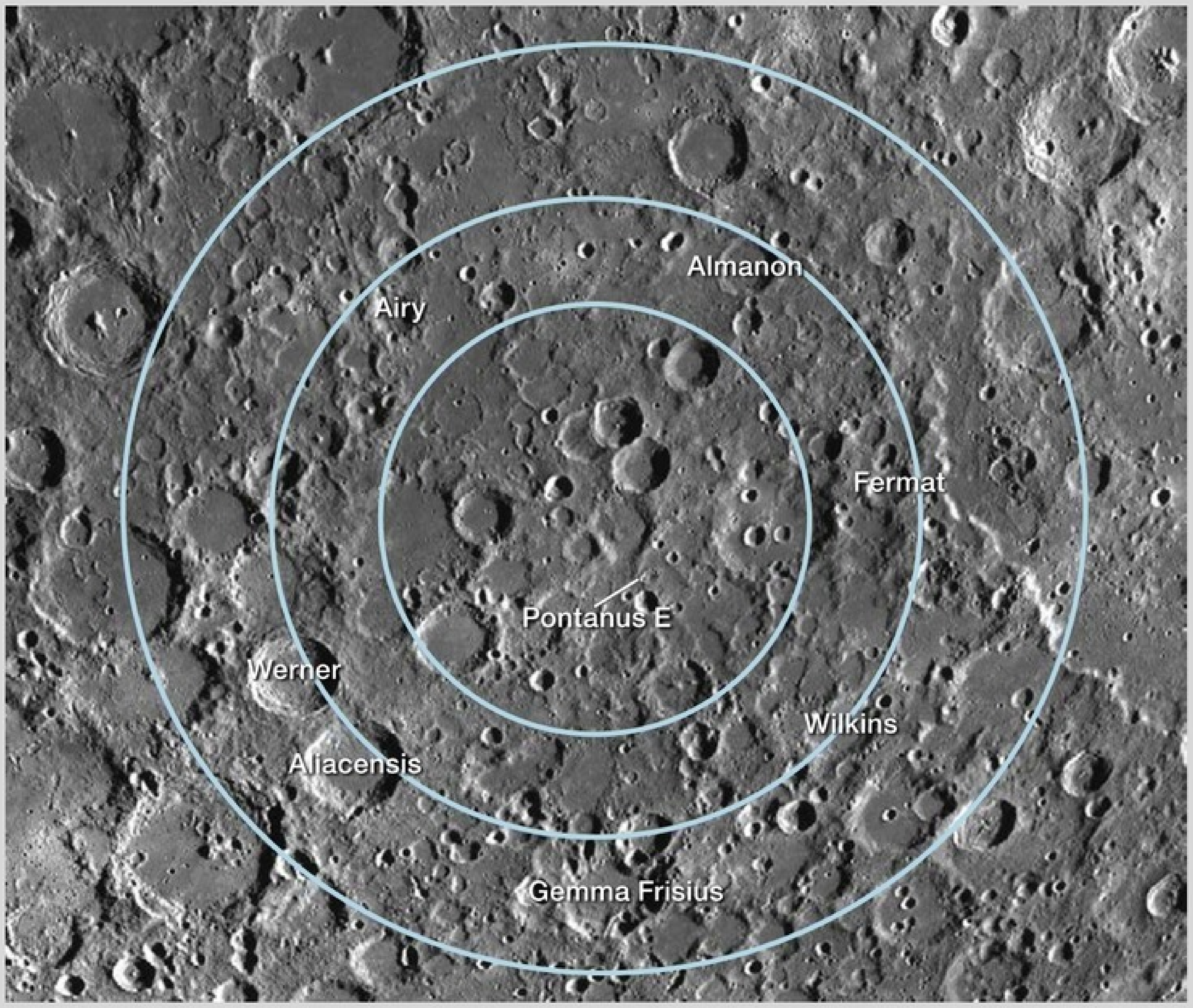
The Werner-Airy Enigma

Does this lunar region contain a forgotten basin?

All parts of the lunar surface have a history, but if there are no grand craters, towering mountains, or curving rilles, that history is more challenging to discern. One such place stretches about 500 kilometers west from the northwestern extent of **Rupes Altai** scarp and nearly to Mare Nubium. This area I'm writing about is made up of neither smooth maria nor heavily cratered highlands but instead contains about a dozen large, flat-floored craters and smaller, partially rimmed, and degraded craters with light-hued, smooth material within and between the craters. What is the history of this unusual area?

More than 50 years ago, pioneer lunar astronomer Ralph Baldwin noticed that portions of this area are relatively bland and suggested that it could be the remains of an ancient, highly degraded impact basin. As the image below shows, a circle that encloses much of the area is roughly traceable clockwise from **Almanon** through **Fermat** and **Wilkins** to **Gemma Frisius** at its southern extent. It then continues northwest through **Aliacensis** and **Werner** on the west, past **Airy** to the northeast, and back to Almanon. Although this putative Werner-Airy Basin had been included in various lists of possible impact basins, most scientists discount it, for several reasons. It isn't topographically lower than its environs, it has few (if any) remnants of a rim, and NASA's GRAIL mission failed to detect any gravitational anomalies within its proposed borders — all typical basin features. However, China's recent Geologic Map of the Moon (*S&T:* Aug. 2023, p. 52) accepts the Werner-Airy feature as a basin, with rings bearing diameters of 350, 515, and 765 km. These rings are difficult to identify visually.



▲The area above is sometimes designated as the Werner-Airy Basin. The location of the area's three concentric rings comes from the Chinese Academy of Sciences Geologic Map of the Moon.

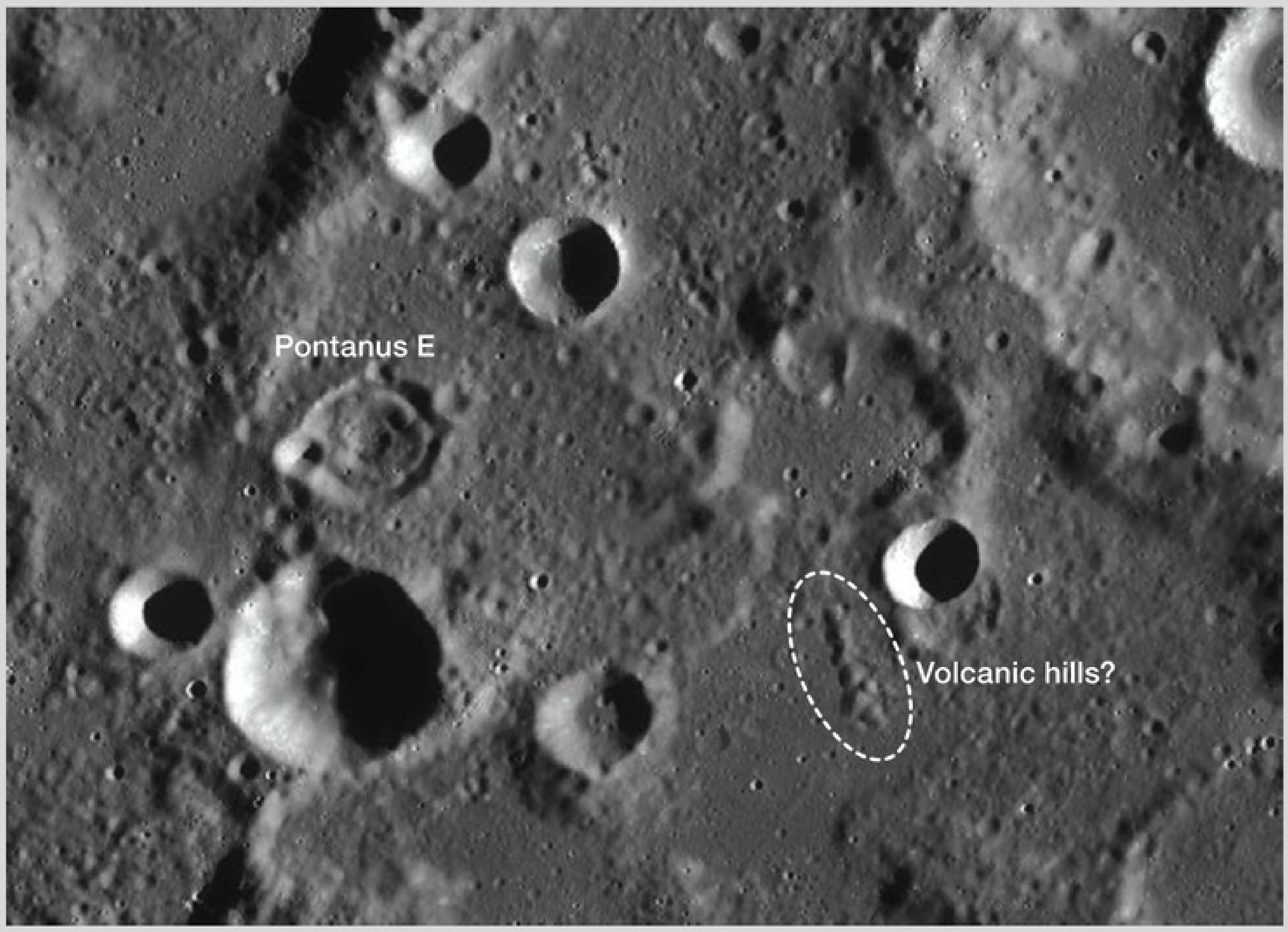
The most common characteristic of the Werner-Airy area is its widespread patches of smooth plains. During the 1960s, such plains were commonly interpreted as old volcanic materials different from the dark, basaltic lavas making up the maria. Then in 1972 the Apollo 16 spacecraft landed just north of the Werner-Airy Basin and collected samples. But as astronaut Ken Mattingly immediately recognized, the rocks they found were not volcanic but comprised of fractured and pulverized material. Mattingly's comment was: "Well, it's back to the drawing boards, or wherever geologists go" to come up with a better theory.

Due to the Apollo 16 results, all bright, smooth lunar plains are considered fluidized ejecta from the formation of basins and large craters. And probably almost all are, but two features in the Werner-Airy Basin create a bit of uncertainty. Within the inner ring of the putative basin is **Pontanus E**, a 13-km-wide, concentric crater. Slightly more than 100 concentric craters are found on the Moon, and the majority are on or very near maria. The inner-donut-ridge of a concentric crater is thought to form by the intrusion of magma through faults beneath the crater, uplifting a ring around the floor. The existence of Pontanus E implies that magma was once under the middle of this region.

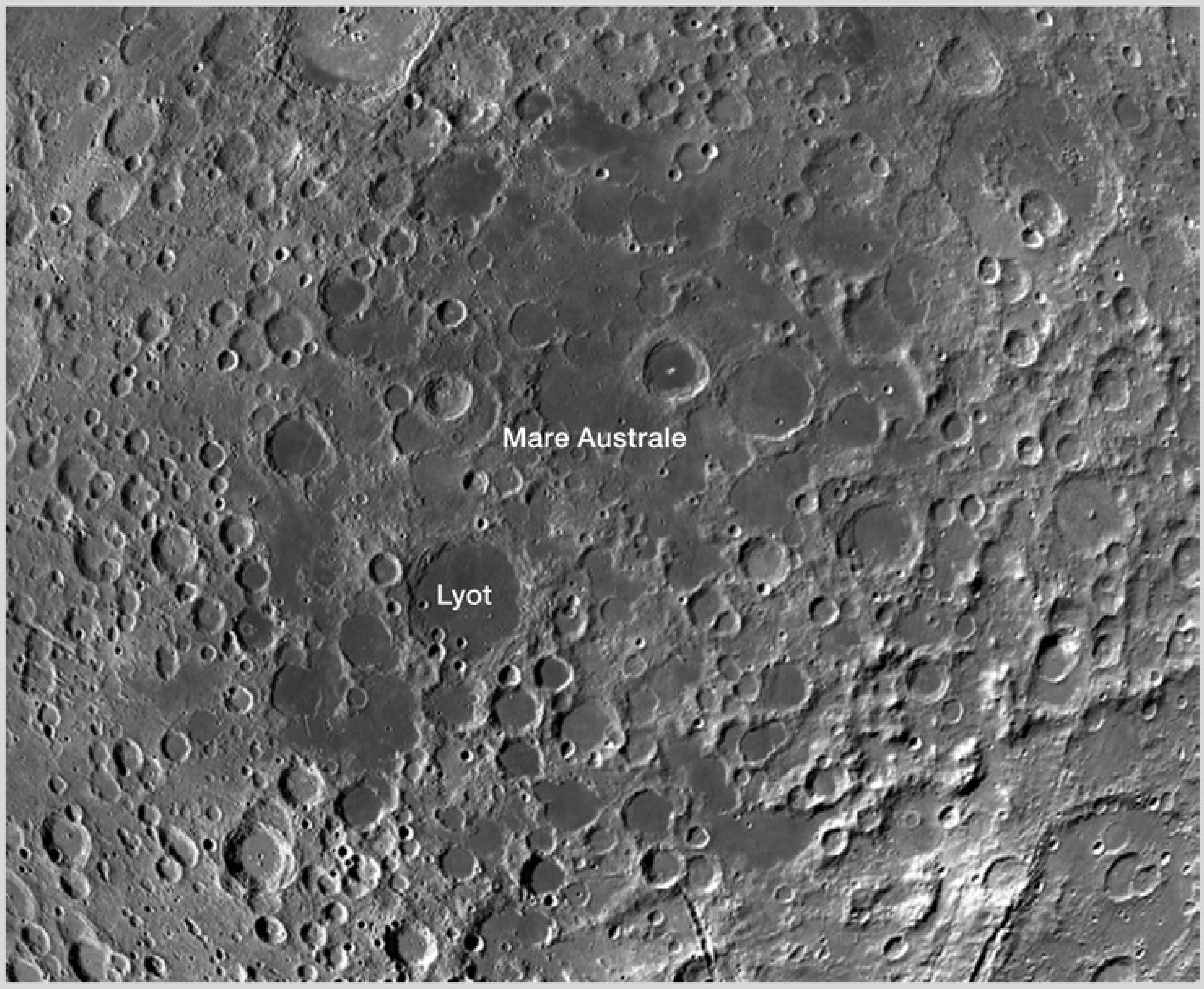
Some 50 km southeast of Pontanus E are 8 small hills about 2-3 km wide in a 12-km straight line. They are smaller and steeper-sloped than volcanic mare domes. Any one of the hills could be random topography, but being adjacent to one another and in a straight line strongly suggests that they formed by pockets of magma that erupted through a fault onto the surface. However, the features aren't dark, nor do they have compositions like mare basalts. If they are volcanic features, for some reason they have a different composition from mare lavas, or they have been blanketed by highlands ejecta.

Other than a small number of silica-rich volcanic features, such as the Gruithuisen domes, there are very few lunar magmas different from mare basalts. Thus, the concentric crater and line of hills are suggestive of unusual volcanism. However, the existence of the concentric crater and line of hills supports the interpretation that the Werner-Airy Basin could be real, because basins deeply fracture the lunar crust and provide conduits for subsurface magmas to reach the surface.

Look closely at the Werner-Airy area. It's vaguely definable, with smooth plains and more degraded craters than the surrounding terrain. Its history is clearly different. Its large size and circular shape are consistent with it being the remnant of an ancient, highly eroded basin. In fact, Chinese astronomers list it as the second oldest basin, after the 2,400-km-diameter South Pole-Aitken Basin. However, recent studies have demonstrated that every recognizable impact basin has a gravity anomaly due to the upward flow of the lunar mantle beneath. If Werner-Airy is a basin, it may have formed so early in lunar history that the Moon's thin crust wasn't strong enough to retain the topographic and gravitational anomalies of the basin, and it isostatically adjusted to erase its excavated depression and mountainous rim.



▲The chain of hills southeast of Pontanus E (lower right) likely has a volcanic origin.



▲With the exception of its dark maria, Mare Australe resembles the putative Werner-Airy Basin.

Another area quite similar to Werner-Airy is **Mare Australe** at the Moon's southeast limb. Australe is a roughly 1,000-km, near-circular, rimless, non-depressed area with smooth plains located within and between large craters. But the smooth plains are dark mare lavas, not light plains. The northern portion of Australe has a gravity anomaly and is considered a basin. But the southern portion, like Werner-Airy, has no anomaly and isn't regarded as such. And yet, somehow, deep conduits brought significant mare lavas to flood the region's craters and the spaces between them.

The Werner-Airy area has a past we don't yet understand, which is an intriguing mystery deserving detailed investigation.

■ Contributing Editor **CHUCK WOOD** enjoys deciphering visual clues that hint at the history of the Moon's formation.