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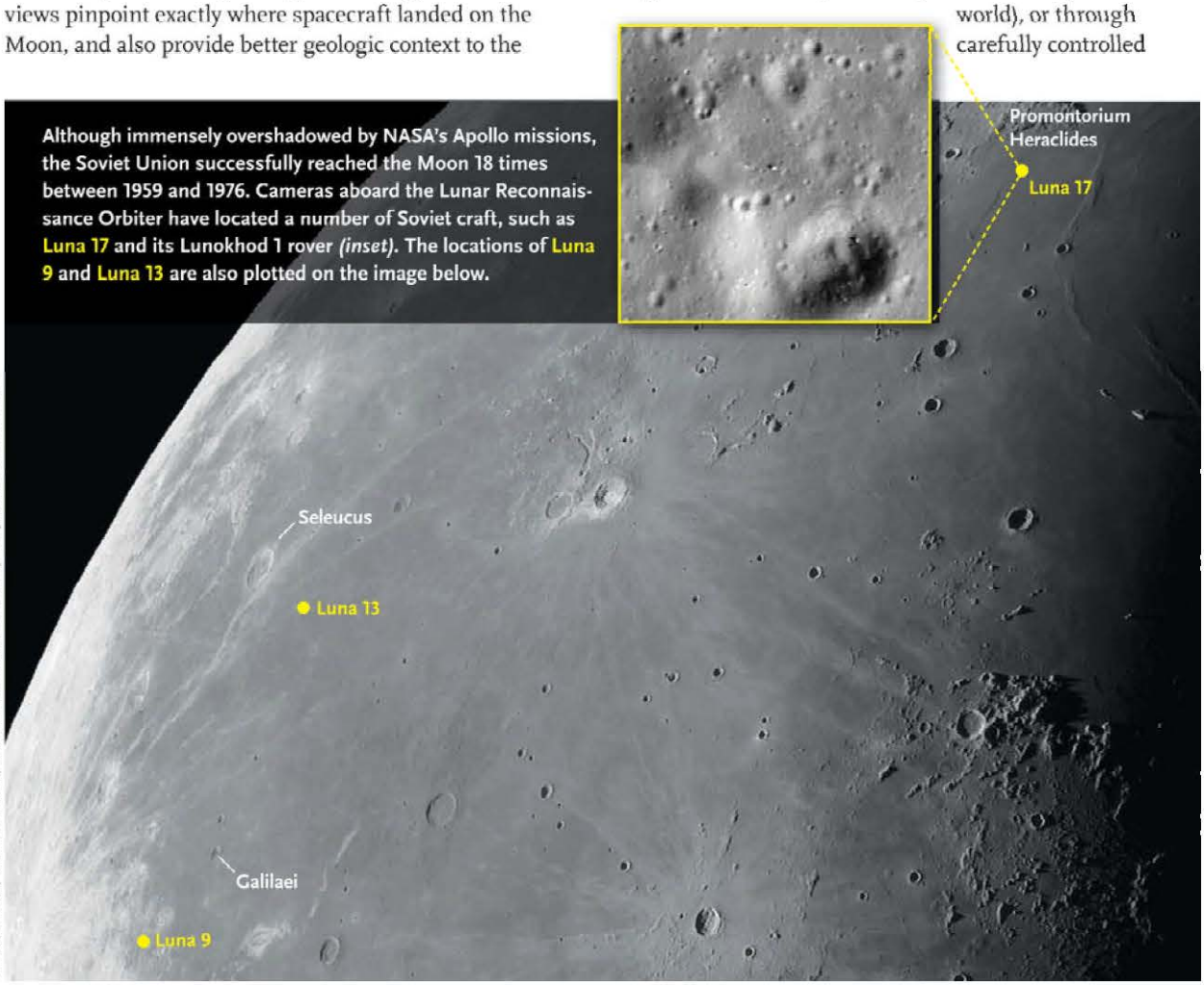
Touring Soviet Landing Sites

LRO reminds us of the great Soviet accomplishments on the Moon.

SINCE ENTERING orbit in June 2009, NASA's Lunar Reconnaissance Orbiter (LRO) cameras have snapped thousands of ultra-high-resolution images of the Moon's surface, revealing tiny features as little as 20 inches (50 centimeters) across. But the observations that have really captured the public's interest are the images of spacecraft that reached the Moon. Finally, we can show the skeptics new pictures of the Apollo landing modules, equipment deployed by astronauts, and even their trails of footsteps where they walked 40 years ago. These hyper-resolution views pinpoint exactly where spacecraft landed on the Moon, and also provide better geologic context to the pictures they took and the samples they returned. This is especially valuable for the Soviet missions, whose landing locations were often uncertain at best; LRO has already imaged some. Mission scientists hope to find them all.

This new information also makes it timely for observers to hunt down the areas where these Soviet relics reside. Their locations are far less familiar than the Apollo landing sites, but no less historically important. At least 18 Soviet spacecraft landed on the Moon, either by crashing, such as Luna 2 (the first spacecraft to impact another world), or through carefully controlled



Although immensely overshadowed by NASA's Apollo missions, the Soviet Union successfully reached the Moon 18 times between 1959 and 1976. Cameras aboard the Lunar Reconnaissance Orbiter have located a number of Soviet craft, such as Luna 17 and its Lunokhod 1 rover *(inset)*. The locations of Luna 9 and Luna 13 are also plotted on the image below.

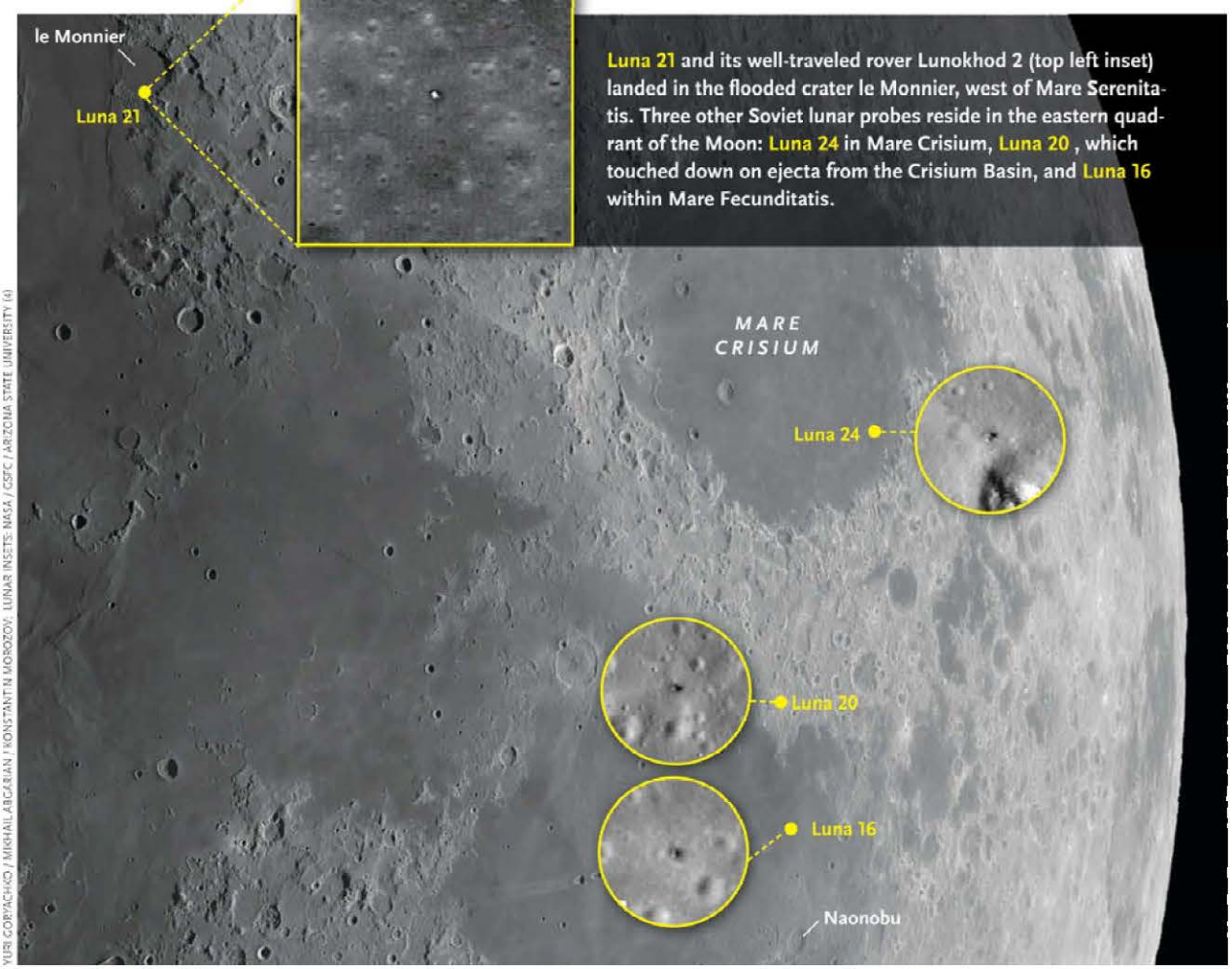
YURI GORYACHKO / MIKHAIL ARGAMAN / KONSTANTIN MOROZOV; INSET: NASA / GSFC / ARIZONA STATE UNIVERSITY

landings. Some of these ambitious Soviet accomplishments remain unmatched by NASA.

There were three classes of successful Soviet landers. Luna 9 and 13, launched in January and December 1966, respectively, were the first vehicles to survive landing on the surface. Like most early lunar missions, the location for their landing was less important than their survival. Luna 9 touched down along the western shore of Oceanus Procellarum, south of the crater **Galilaei**. The photos it beamed back to Earth show a pebbly surface sprinkled with small craters and boulders. Luna 9 proved that the lunar surface could support a spacecraft — it didn't sink into layers of dust. It's easy to find the general area where human hardware first landed safely, but LRO's cameras have yet to spot the exact position. Luna 13 landed on a mare plain that looks very similar to the Luna 9 area, southeast of the crater **Seleucus**. Luna 13 reinforced the idea that maria were safe landing zones.

In 1970 Luna 17 landed about 30 miles (50 kilometers) southwest of **Promontorium Heraclides**, the headland of Sinus Iridum that juts into northern Mare Imbrium. This region is easy to find and observe, but you won't find any distinctive features on this flat mare plain. Luna 17 carried Lunokhod 1, an ungainly looking wheeled contraption that functioned remarkably well. This lunar rover slowly drove across the lunar surface, remotely controlled by operators near Moscow. Lunokhod 1 traveled through a region littered with craters tens of feet across, often with boulders strewn along their rims. For the next million years, 6 miles (10 km) of rover tracks will commemorate the first drive on another world.

Luna 21, carrying the Lunokhod 2 rover, touched down in early 1973 on the floor of **le Monnier**, a flooded crater filled with mare lavas that spilled over from Mare Serenitatis. The landing area near the southern rim of the crater has one feature just barely visible from Earth — a narrow trough that the Russians named "Straight Rille." This rille is perhaps the most dramatic feature imaged by the Soviet lander missions, with each side of the trough exposing boulders, and a gentle valley between them. As you observe this area, think of the plucky rover that traveled south to see the crater rim, and remains parked on the surface at the end of its twin tread tracks. It covered 23 miles (37 km) of lunar terrain.



Luna 21 and its well-traveled rover Lunokhod 2 (top left inset) landed in the flooded crater le Monnier, west of Mare Serenitatis. Three other Soviet lunar probes reside in the eastern quadrant of the Moon: **Luna 24** in Mare Crisium, **Luna 20** , which touched down on ejecta from the Crisium Basin, and **Luna 16** within Mare Fecunditatis.

YURI GORYACHEV / MIKHAIL ARCARIAN / KONSTANTIN MOROZOV; LUNAR INSETS: NASA / GSFC / ARIZONA STATE UNIVERSITY (4)

The third class of Soviet era landers are sample-return missions. These were the Soviet Union's most ambitious attempts to return lunar samples to Earth before Apollo 11. Two sample-return missions failed before Apollo 11's success, followed by another three. Finally, the robotic missions Luna 16 (1970), 20 (1972), and 24 (1976) succeeded, bringing 0.7 pound (0.3 kg) of lunar soil samples back to the motherland. Despite the tiny amount of returned material, these samples yielded detailed measurements of their ages and compositions. All three landings were near southern Mare Crisium, providing sample information far to the east of the regions visited by the Apollo astronauts.

Luna 16 landed "blind" at night among the mare ridges north of the crater **Naonobu** in Mare Fecunditatis — its lamps malfunctioned, so no pictures from the surface were possible. Luna 16 became the first fully automated spacecraft to return samples from another world.

Luna 20 touched down south of Mare Crisium, roughly 60 miles north of Luna 16. Although this is a highland area, images returned by Luna 20's camera suprisingly depict a relatively smooth landscape. The final spacecraft to reach the Moon during the Apollo–Luna era was Luna 24, landing within southern Mare Crisium. The sample of soil returned from Luna 24 imply the region was flooded by multiple events. You can see all three of these landing areas in a high-magnification view. Have a look for yourself! ✦

For a daily lunar fix, visit contributing editor ***Charles Wood's*** *website: lpod.wikispaces.com.*

The Moon • July 2010

Highlighted Mission	Location	Coordinates
A Luna 9	Oceanus Procellarum	8°N, 64°W
B Luna 13	Oceanus Procellarum	19°N, 62°W
C Luna 16	Mare Fecunditatis	1°S, 56°E
D Luna 17	Mare Imbrium	38°N, 35°W
E Luna 20	South of Mare Crisium	4°N, 56°E
F Luna 21	le Monnier (crater)	26°N, 30°E
G Luna 24	Mare Crisium	12°N, 62°E

Phases

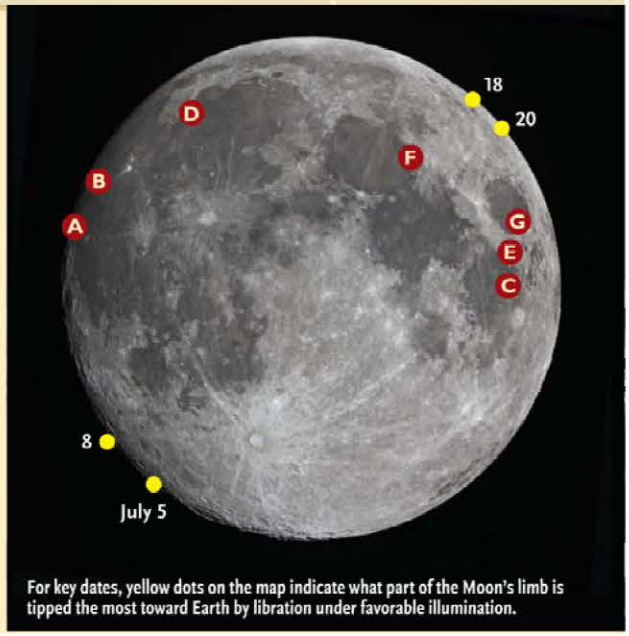
Last quarter	July 4, 14:35 UT
New Moon	July 11, 19:40 UT
First quarter	July 18, 10:11 UT
Full Moon	July 26, 1:37 UT

Distances

Apogee 251,677 miles	July 1, 10h UT diam. 29′ 45″
Perigee 224,386 miles	July 13, 11h UT diam. 32′ 5″
Apogee 252,248 miles	July 29, 00h UT diam. 29′ 19″

Librations

Hausen (crater)	July 5
Mare Orientale	July 8
Compton (crater)	July 18
Mare Humboldtianum	July 20



For key dates, yellow dots on the map indicate what part of the Moon's limb is tipped the most toward Earth by libration under favorable illumination.

S&T: DENNIS DI CICCO