Scanning urban roads with Multichannel GPR to accurately identify hidden problems

Detecting subsurface defects and voids in high traffic areas

A transportation hub in China, with heavy traffic, had previously undergone numerous repairs. Regular inspections were now crucial to assessing its health and ensuring smooth urban traffic flow.

A professional testing unit was invited to conduct a comprehensive inspection of key areas of the road section.

Detailed survey to clarify road conditions

After the inspection team arrived at the scene, they found that the road surface was scattered with many dividing lines caused by different paving materials. The joints between old and new asphalt, and the transition zones between concrete and asphalt were also clearly visible. Some areas also had obvious signs of secondary construction, such as local repair blocks and edges of overlay layers. Their texture, color and flatness were significantly different from the surrounding original road surfaces.

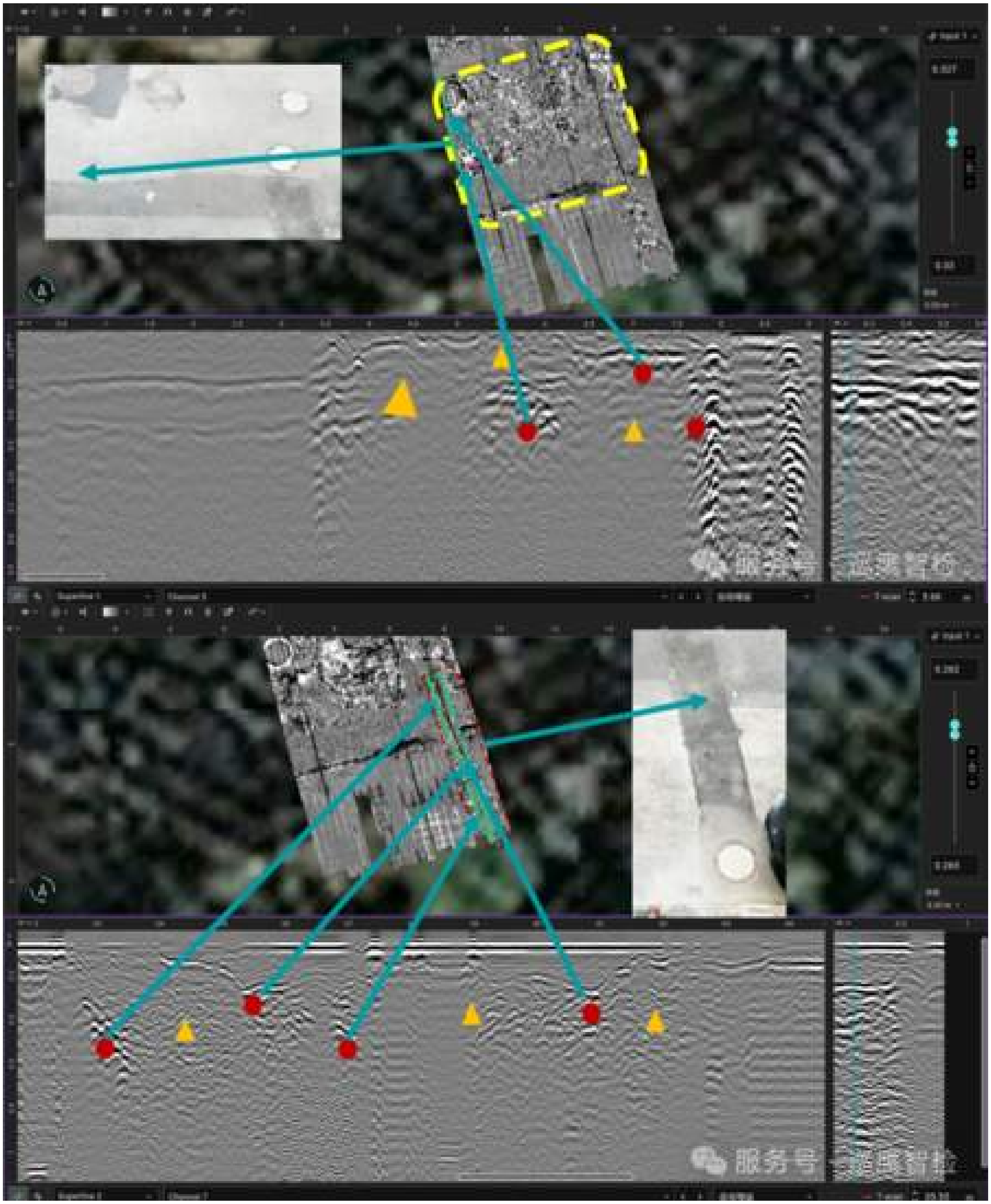
Based on this, the core focus of this inspection is to evaluate the integrity of the existing structure and check whether there are hidden defects such as voids, delamination, and non-compactness inside and below the added layer.

Empowered by science and technology, accurate detection of “hidden diseases”

In order to accurately obtain the structural information inside the road, the inspection team used the Proceq GS9000 multichannel ground penetrating radar (GPR) for non-destructive detection.

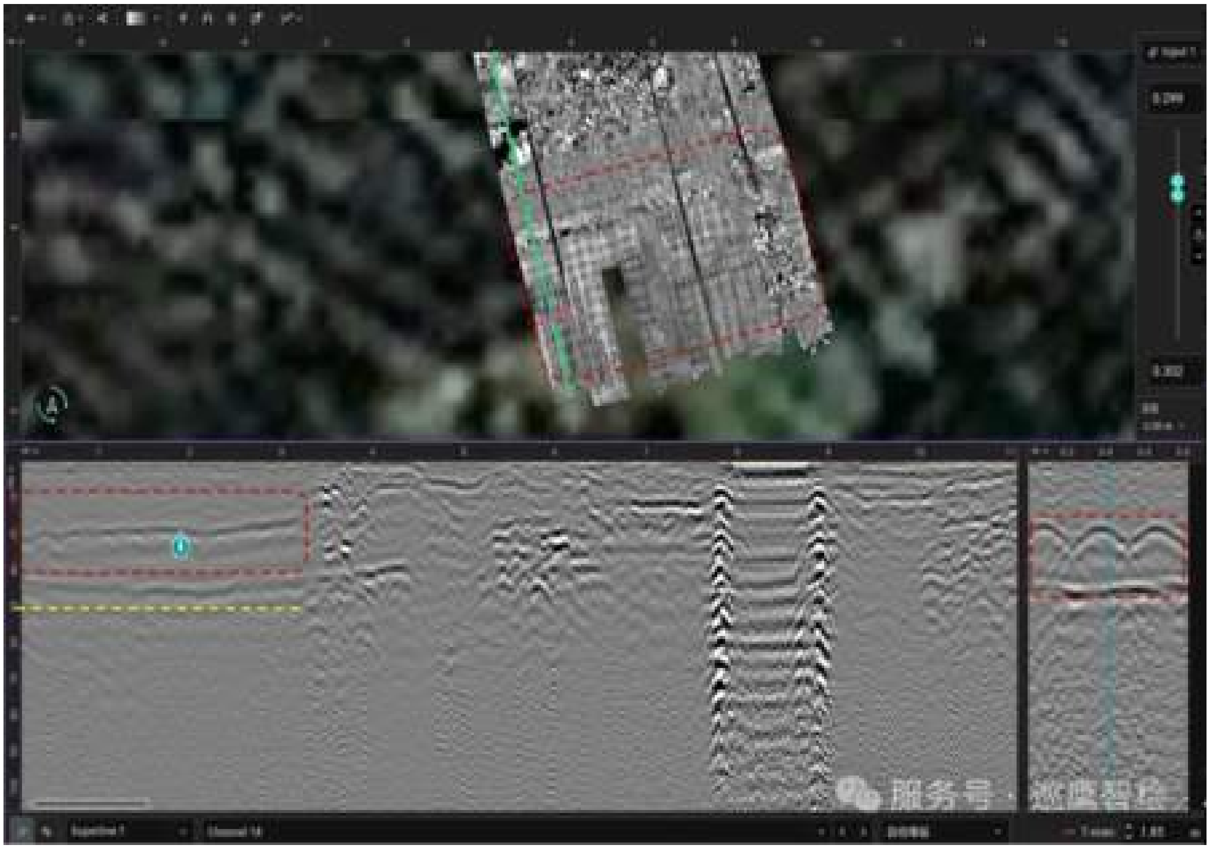
During the detection process, inspectors can understand the underground situation in real-time through radar depth slicing and B-scan images.

As shown in the video above, at a depth of 8 cm, large areas of typical void signals (characterized by high amplitude and clear boundaries) and non-dense signals (characterized by being messy and discontinuous) began to appear, and were mainly distributed within a depth of 60 cm.



Yellow triangle indicates: non-dense signal Red circle indicates: short signal

This suggests that there may be extensive voids and severe decompression beneath the road. However, no obvious delamination of the road structure was detected in the radar signal. Combined with on-site photos, this area may have undergone multiple damage and repairs, with poor results.

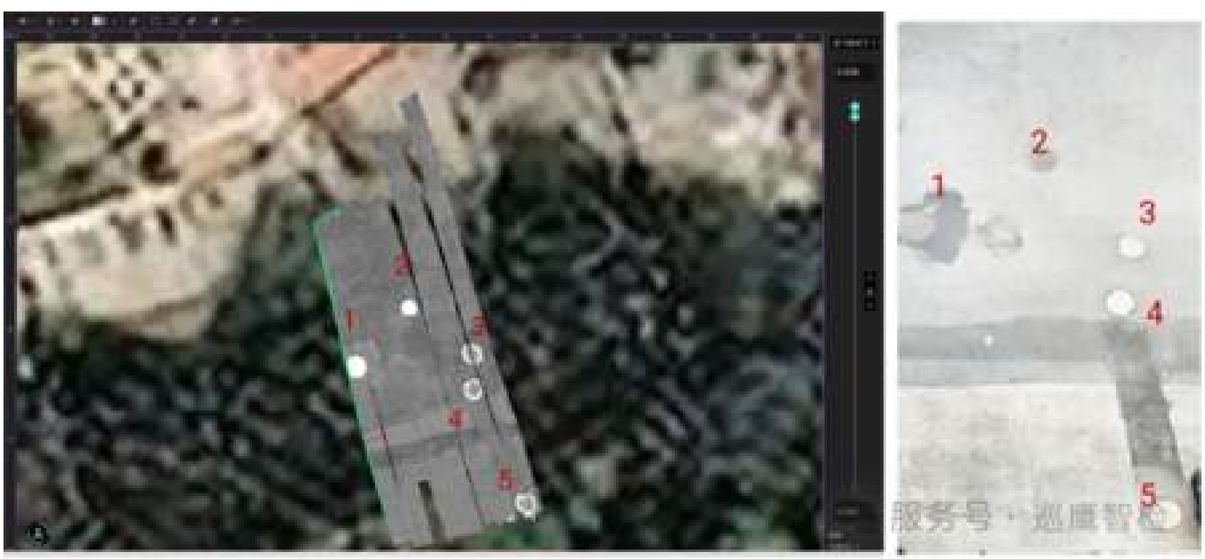


Furthermore, the depth slice and radar B-scan images clearly show the presence of a crisscrossing mesh of steel bars in the red framed area of the inspection area, buried approximately 30 centimeters deep. A clear layered reflection signal is visible approximately 42 centimeters below the mesh (marked by the yellow dashed line).

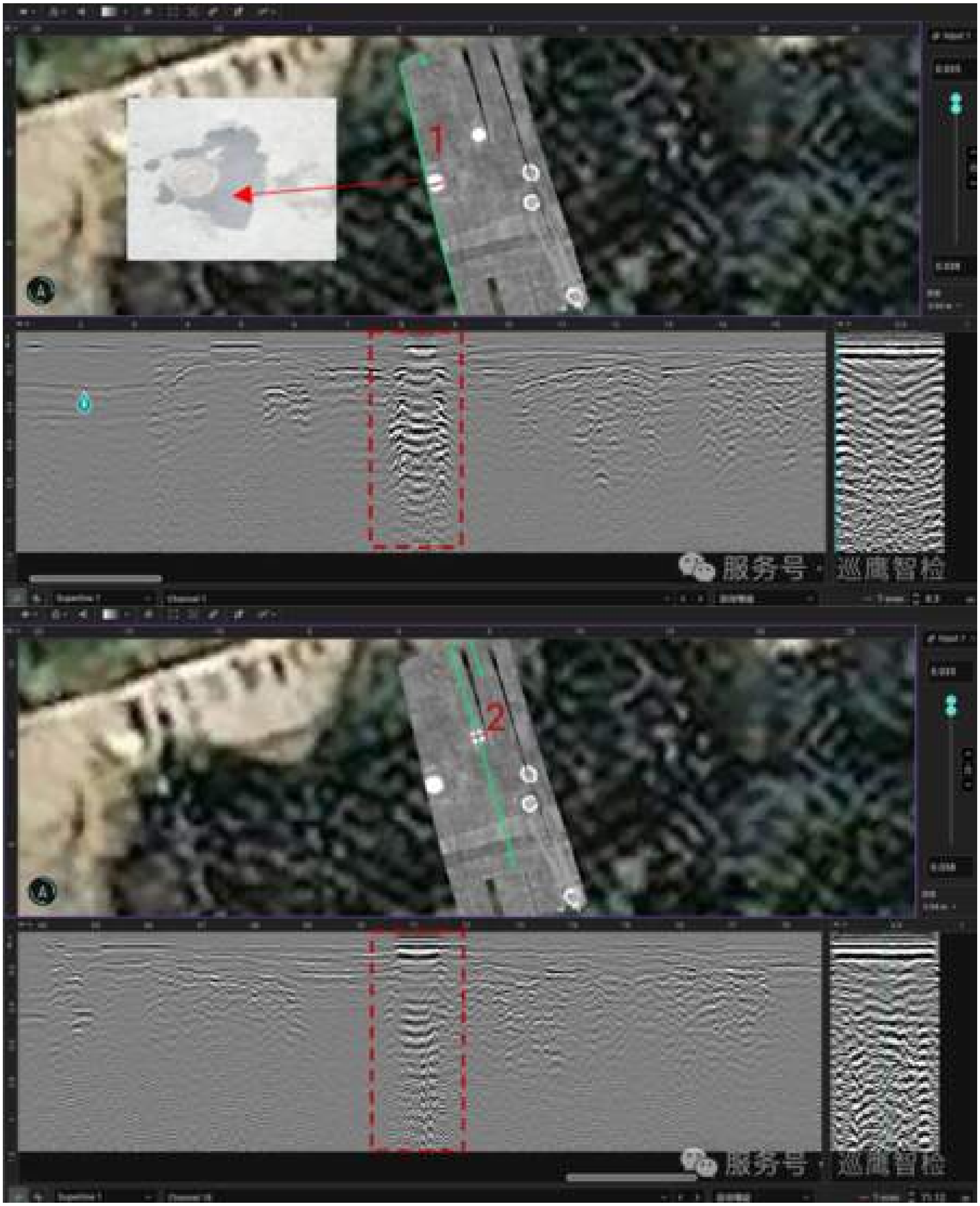
Based on comprehensive judgment, during the construction of this area, a layer of concrete about 10 cm thick may have been laid first, and then the steel mesh was laid.

Unraveling the hidden problems

In addition to the overall structural problems of the road, the inspection team also conducted detailed inspections around the manhole covers on the road surface and the underground pipeline network.

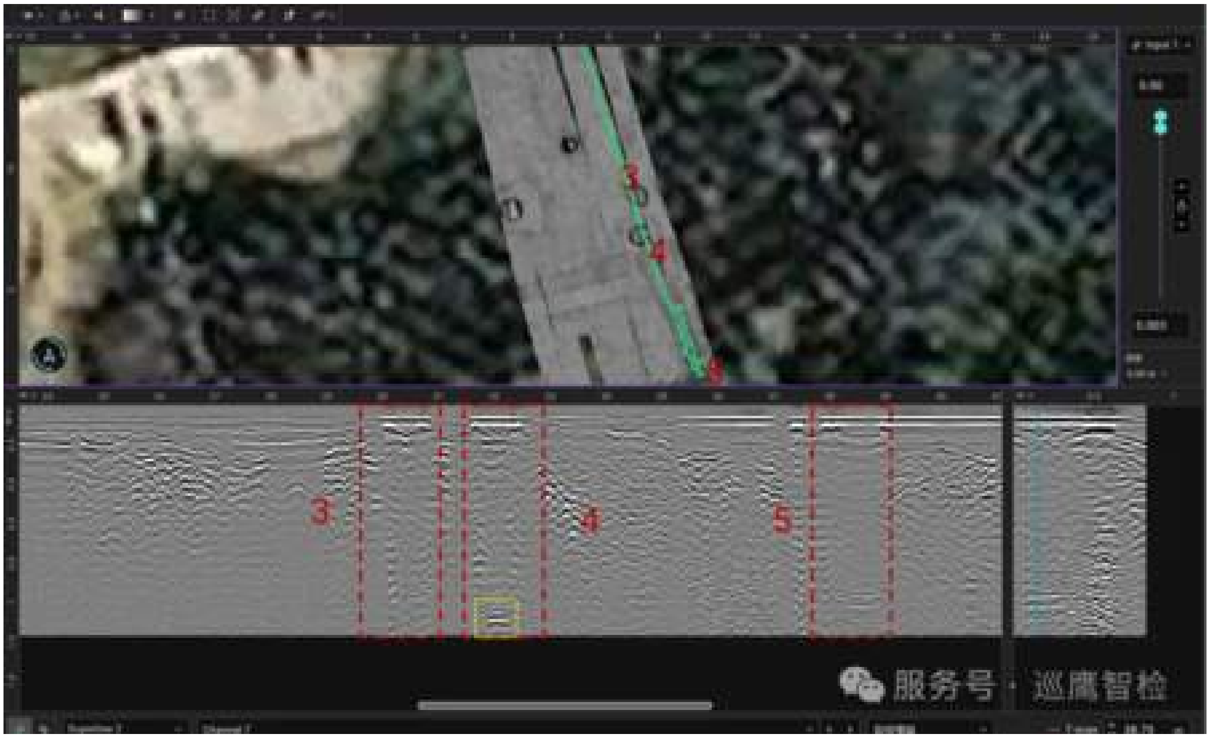


The radar depth slice clearly showed five circular reflections, which, when compared with on-site photos, were confirmed to be reflections from five municipal manhole covers. Manhole covers 1 and 2 were metal, while covers 3 through 5 were concrete (shown as hollow on the radar image).



By observing the radar B scan images of manhole covers No. 1 and No. 2, it was found that their reflected signals showed significant multiple reflection oscillation effect in the depth direction, which is a typical feature of metal manhole covers.

However, unlike cover No. 2, cover No. 1 exhibited a strong reflection signal around its edges. Combined with on-site photos showing signs of repair and new construction around cover No. 1, the inspection team concluded that there may be a void or defect beneath cover No. 1, indicating that the well had been damaged and that repairs had not met expectations. For concrete manhole covers No. 3 to 5, their radar B scan images did not show multiple reflection oscillations.

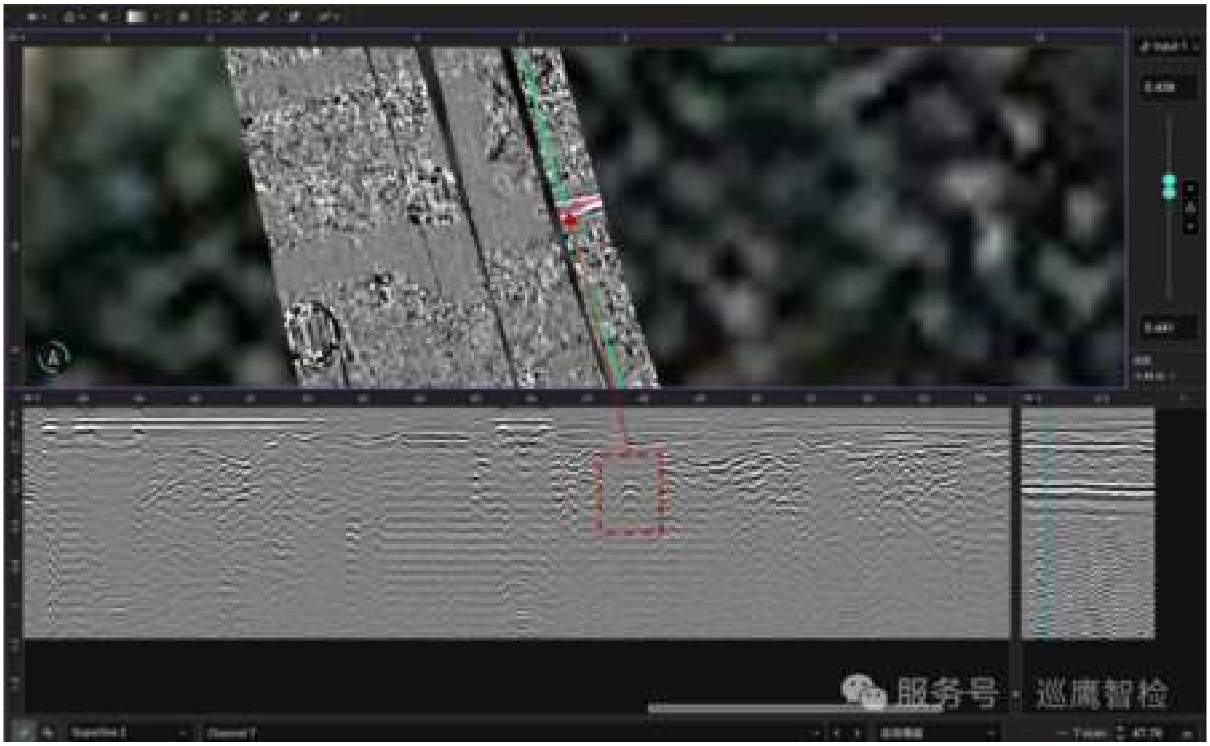


A strong reflection signal (marked in yellow) is detected deep below the No. 4 manhole cover, presumably originating from the shaft floor. The depth was calculated using the radar signal's two-way travel time, which was recorded at 18.6 nanoseconds. Substituting this into the following depth calculation formula yields an estimated depth of 2.79 meters.

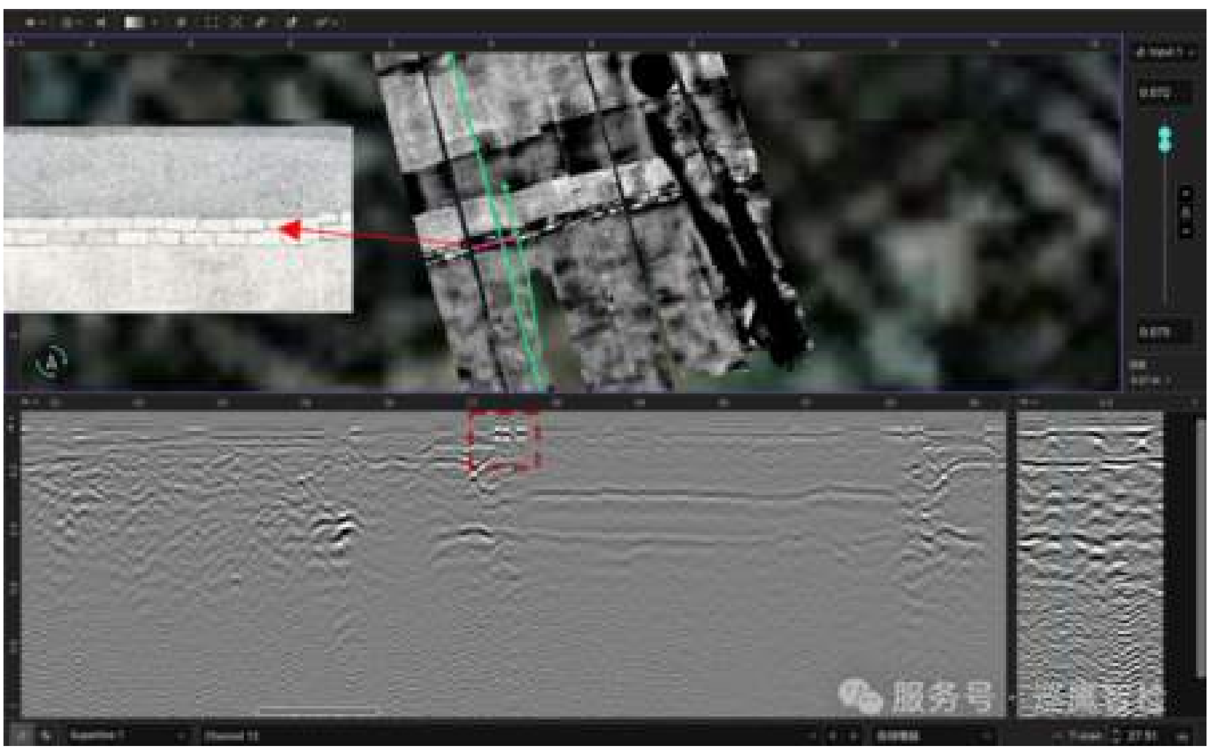
$$d = \frac{c}{\sqrt{\varepsilon_r}} \times \frac{t}{2}$$

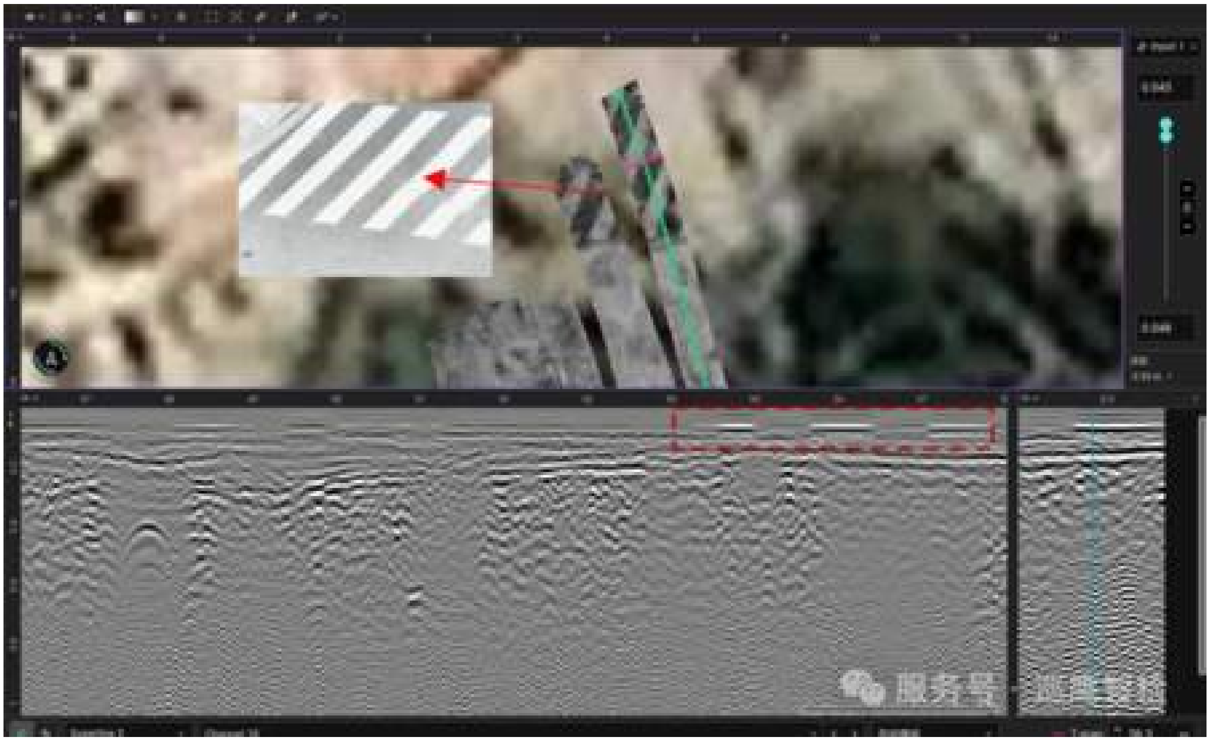
Where c is the speed of light in vacuum, 0.3 m/nsec, and t is the round-trip time.

ε_r is the relative dielectric constant of the medium, the relative dielectric constant of air is 1.



In terms of underground pipeline detection, radar B scan and depth slice showed that there was a reflection signal from a metal pipe at a depth of about 40 cm.





In addition, the depth slice and radar B-scan image also clearly showed several obvious reflection signals. After on-site comparison, it was confirmed that the reflection sources were bricks and zebra crossings.

Check out more [subsurface investigations with GPR] in our Tech Hub.