NO PREP

Satellite Archaeology

Finding Sites from Space

Includes: Student reading, case study, differentiated questions, teacher key

Name: Period: Date:

Satellite Archaeology: Finding Sites from Space

Eyes in Orbit

The idea of finding ancient ruins from space sounds like science fiction, but satellite archaeology has been a reality for decades and is growing more powerful every year. The basic concept is straightforward: satellites orbiting the earth carry cameras and sensors that capture images of the ground surface in extraordinary detail. Some modern commercial satellites can resolve features as small as 30 centimeters across, which means they can detect individual stones, walls, and even large artifacts from hundreds of kilometers above the earth. But satellite archaeology goes far beyond simply taking photographs. The most valuable satellite sensors detect wavelengths of light that are invisible to the human eye. Multispectral and hyperspectral sensors capture data in infrared, near-infrared, and other wavelength bands that reveal information hidden in ordinary photographs. Buried walls and foundations change the moisture content and chemical composition of the soil above them, which in turn affects how vegetation grows. A buried stone wall might cause the

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Sarah Parcak: The Space Archaeologist

No one has done more to popularize and advance satellite archaeology than Dr. Sarah Parcak, a professor at the University of Alabama at Birmingham. Parcak has used satellite imagery to identify thousands of potential archaeological sites across Egypt, including what may be seventeen previously unknown pyramids, over a thousand lost tombs, and more than three thousand ancient settlements. Her work demonstrated that even in a country as thoroughly explored as Egypt, satellite technology could reveal vast amounts of undiscovered archaeology. In 2016, Parcak won the prestigious TED Prize, which came with one million dollars and a platform to make a wish to change the world. Her wish was to create a citizen science platform called GlobalXplorer that would allow ordinary people to help analyze satellite imagery for signs of archaeological sites and looting. The platform works by showing volunteers small tiles of satellite imagery and asking them to identify features like geometric shapes, unusual soil marks, or evidence of illegal digging. By crowdsourcing the analysis, Parcak hoped to multiply the number of eyes scanning satellite data for hidden sites. Parcak's work has also highlighted the darker side of satellite archaeology: its use in monitoring the destruction of cultural heritage. In conflict zones and politically unstable regions, looting of archaeological sites often increases dramatically as law enforcement collapses and economic desperation drives people to dig for sellable artifacts. Satellite imagery can detect looting in near-real-time by comparing images taken at different dates and looking for new pits, disturbed soil, and vehicle tracks at known archaeological sites.

Watching Looting in Real Time

The ability to monitor archaeological sites from space has become a critical tool for heritage protection, particularly in regions experiencing conflict. During and after the political upheaval in Egypt beginning in 2011, satellite imagery revealed a dramatic increase in looting at archaeological sites across the country. Researchers compared images taken before and after the unrest and documented thousands of new looting pits at sites that had been relatively undisturbed for years. The situation was even more devastating in Syria and Iraq, where the civil war in Syria and the rise of the Islamic State created conditions of total lawlessness at some of the world's most important archaeological sites. Satellite monitoring showed systematic looting at sites like Apamea in Syria, where images revealed thousands of

pits dug in an organized grid pattern, suggesting large-scale, coordinated theft rather than opportunistic digging. At Dura-Europos, another Syrian site, satellite images showed the site being progressively destroyed over months. The Islamic State took the destruction further by deliberately bulldozing and detonating ancient monuments as part of a campaign against what they considered idolatrous representations of the pre-Islamic past. Satellite imagery documented the destruction of Nimrud and Hatra in Iraq and Palmyra in Syria, providing evidence that has been used in international efforts to hold individuals accountable for cultural heritage crimes. The images also helped heritage organizations prioritize which sites were most at risk and allocate limited protection resources. Despite the power of satellite monitoring, there is a frustrating gap between seeing destruction and being able to stop it. Satellite imagery can document looting and demolition in near-real-time, but turning that information into effective action on the ground requires functioning governments, law enforcement, and political will, all of which may be absent in conflict zones. The result is that archaeologists and heritage professionals sometimes find themselves watching irreplaceable sites being destroyed in high-resolution imagery with no ability to intervene.

The Limits of Looking Down

Satellite archaeology has significant limitations that temper its impressive capabilities. The most fundamental is resolution. While commercial satellites continue to improve, even the best current imagery cannot detect small artifacts, subtle stratigraphic differences, or the kind of fine-grained detail that excavation reveals. Satellite archaeology is excellent for finding sites and monitoring their condition, but it cannot replace the detailed investigation that comes from being physically present on the ground. Cloud cover is a constant challenge. Optical and infrared sensors cannot see through clouds, which means that sites in tropical and equatorial regions, where cloud cover is frequent, are often difficult to survey consistently. This is one reason why LiDAR, which can penetrate vegetation but is limited by clouds as well, and radar-based satellites, which can see through clouds, are increasingly being used alongside traditional optical imagery. Access to high-resolution satellite imagery can also be expensive. While platforms like Google Earth provide free access to moderate-resolution imagery, the highest-quality data from commercial providers can cost thousands of dollars per scene. Some governments

restrict the distribution of satellite imagery over sensitive areas, limiting what researchers can access. And the sheer volume of data produced by modern satellites creates its own challenge: there is far more imagery available than human analysts can review, which is why AI-based analysis and crowdsourcing platforms like GlobalXplorer are becoming essential tools in the field. Despite these challenges, satellite archaeology continues to expand the boundaries of what is possible. Every new satellite launched into orbit adds to the growing archive of earth observation data, and every improvement in sensor technology makes it possible to detect fainter and more subtle traces of the human past. For a discipline that was once limited to what could be seen from ground level, the view from space has opened up an entirely new dimension of discovery.

Key Information: Satellite Archaeology

Detail	Information
How it works	Satellites capture images in visible and invisible wavelengths that reveal buried features through vegetation and soil changes
Multispectral imaging	Detects infrared and near-infrared wavelengths that show differences in vegetation growth and soil moisture over buried structures
Sarah Parcak	Pioneer of satellite archaeology; identified thousands of potential sites in Egypt using satellite data
GlobalXplorer	Citizen science platform created by Parcak allowing volunteers to analyze satellite imagery for archaeological features and looting
Looting detection	Comparing satellite images over time reveals new pits, disturbed soil, and organized theft at archaeological sites
Conflict zone monitoring	Documented looting and deliberate destruction at sites in Egypt, Syria, and Iraq during recent conflicts

Detail	Information
Key limitation: resolution	Cannot detect small artifacts or fine stratigraphic details; best for large-scale site detection
Key limitation: cloud cover	Optical and infrared sensors cannot see through clouds, limiting surveys in tropical regions

Case Study: Watching a City Die

Intelligence analyst Priya Sharma adjusted the contrast on her screen and compared two satellite images of the same archaeological site, taken six months apart. The first image, from January, showed the ancient city of Tell Hamid in northeastern Syria as it had looked for decades: a series of low mounds surrounded by agricultural fields, with clearly visible outlines of ancient walls and structures visible as soil marks on the surface. The second image, from July, was devastating. Hundreds of dark circular pits now covered the site in a rough grid pattern, each one representing a hole dug by looters searching for sellable artifacts. Vehicle tracks crisscrossed the mounds. "They have been at it for months," Priya said to her supervisor, Dr. Osman. "At this rate, the entire site will be destroyed within a year." Dr. Osman stared at the screen. "Can we notify anyone?" Priya shook her head slowly. "There is no functioning government in that area right now. No police, no military willing to protect a ruin. We can document what is happening. We can present the evidence to international organizations. But we cannot stop it." She paused. "That is the worst part of this job. We can see everything, and we can do nothing."

1. Based on the reading, explain how Priya can identify looting at Tell Hamid using satellite imagery. What specific features in the images indicate organized theft rather than natural erosion?

2. Priya says the worst part of her job is that she can see everything but do nothing. How does this reflect the reading's broader discussion of the gap between satellite monitoring and effective heritage protection?

Multiple Choice

1. How do multispectral satellite sensors detect buried archaeological features?

    a) They detect differences in vegetation growth and soil moisture caused by buried walls and foundations

    b) They use sonar signals that penetrate the ground from space

    c) They measure the weight of buried stone structures from orbit

    d) They photograph underground structures directly using X-ray wavelengths and satellite sensing technology

2. What is GlobalXplorer?

    a) A mapping software used exclusively by professional archaeologists

    b) A satellite launched specifically to photograph archaeological sites from orbit

    c) A citizen science platform where volunteers analyze satellite imagery for archaeological features and looting

    d) A government program designed to monitor and protect archaeological sites from looting and conflict destruction

3. What did satellite imagery reveal about looting at Apamea in Syria?

    a) Looting pits were dug in a random, chaotic pattern lacking the organized grid layouts

    b) Thousands of pits were dug in an organized grid pattern, suggesting coordinated theft

    c) The site had not been damaged during the conflict

    d) The site was flooded and inaccessible to looters

Matching

Write the letter of the correct definition on the line next to each term.

Term	Definition
1. ___ Satellite Imagery	A) Sensors that capture data in multiple wavelengths including those invisible to the human eye
2. ___ Multispectral	B) The illegal digging and removal of artifacts from archaeological sites
3. ___ Infrared	C) The ongoing observation of a site over time to track changes, damage, or unauthorized activity
4. ___ Looting	D) Photographs and data captured by cameras and sensors on satellites orbiting the earth
5. ___ Monitoring	E) A wavelength of light beyond what humans can see that reveals temperature and moisture differences

Fill-in-the-Blank

1. Dr. Sarah Parcak, a professor at the University of Alabama at Birmingham, is known as a pioneer of _____ archaeology.

2. Parcak created a citizen science platform called _____ that allows ordinary people to help analyze satellite imagery for signs of archaeological sites.

3. Satellite imagery documented the deliberate destruction of ancient monuments at Nimrud, Hatra, and _____ during recent conflicts in Syria and Iraq.

Short Answer

Answer each question in 2-4 complete sentences.

1. Explain how buried walls and foundations can be detected from space even though they are underground. What happens to the vegetation and soil above buried structures that makes them visible?

2. Why is satellite monitoring of looting important even if it cannot directly stop the destruction? What purposes does the documentation serve?

3. Compare satellite archaeology to LiDAR, which this reading says can penetrate vegetation. What are the strengths and weaknesses of each, and in what situations would an archaeologist choose one over the other?