InSAR

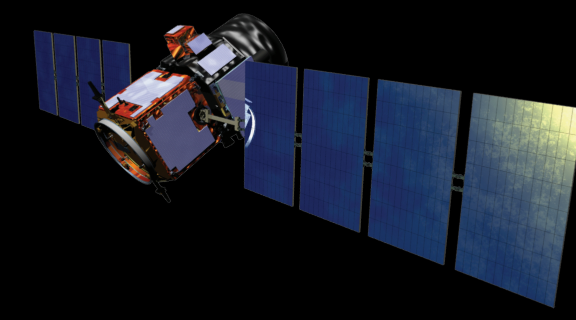
Measuring the Changing Shape of Our Earth from Above

In Interferometric [satellite signals interact]

S Synthetic

A Aperture [pretend you have a really long antenna]

R Radar [emits microwaves and measures echoes]

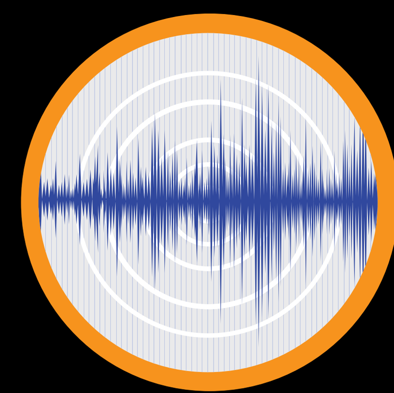


InSAR is a remote sensing geodetic technique for measuring changes in topography and surface deformation. It is a way for scientists to track our constantly changing Earth without physically visiting a location. This means scientists have access to hard-to-reach and hazardous areas, as well as regions too big to study effectively on foot.

Earth Processes We Can Study With InSAR


volcanic movement


ice conditions


earthquakes

landslides


ground subsidence

fluid extraction

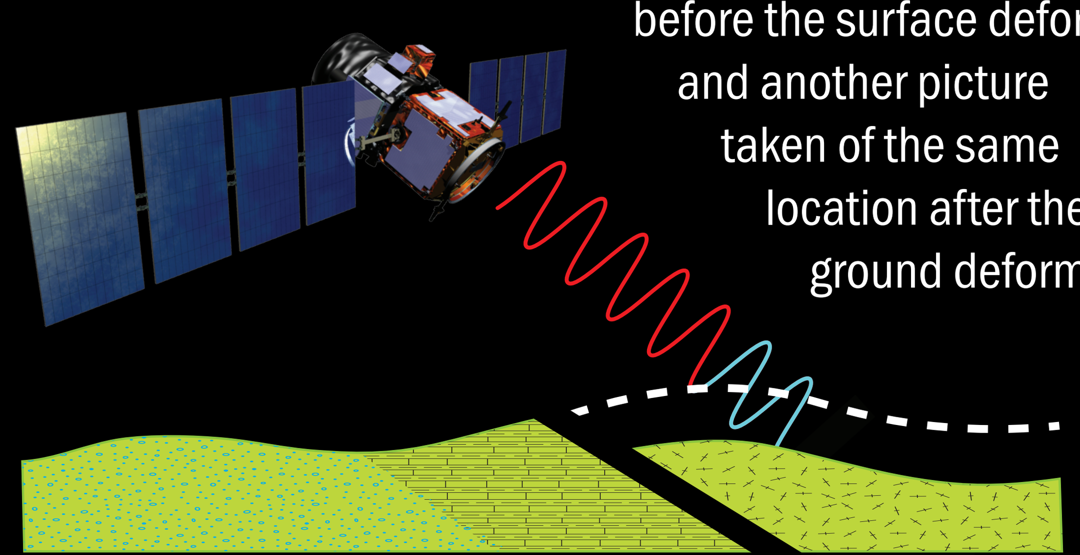

glacier motion

The InSAR technique results in a map of surface change known as an interferogram.

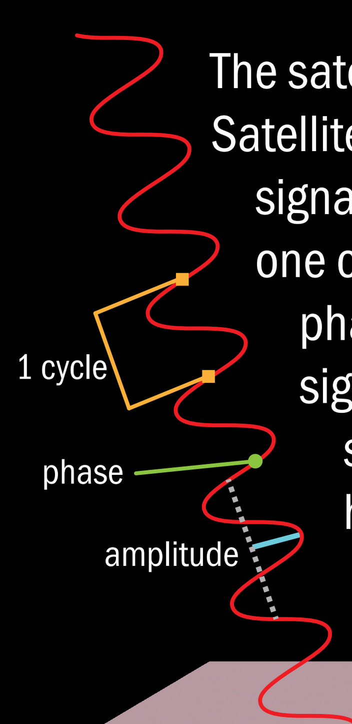
An interferogram shows the difference in the distance a signal traveled from two different satellite passes.

Why do we need two satellite passes?

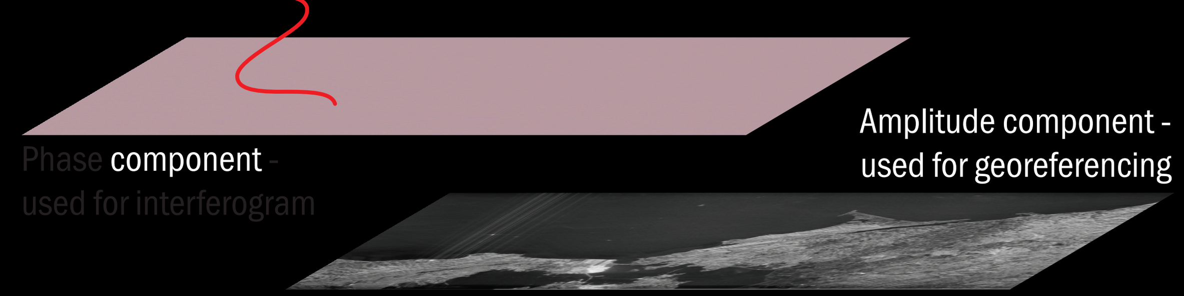
Since an interferogram shows a change in the ground's shape, we need a picture of the ground taken by the satellite before the surface deforms and another picture taken of the same location after the ground deforms.



What is the satellite measuring in each picture?



The satellite pictures are of "phase" and "amplitude." Satellite signals oscillate back and forth. When a signal oscillates back to its starting point, this is one cycle. Any point within one cycle is called the phase of the signal. Amplitude is how far the signal oscillates from its average value. A satellite constructs its picture based on how far into a cycle the signal is when it hits the ground and returns to the satellite.



What does a change in the ground look like?

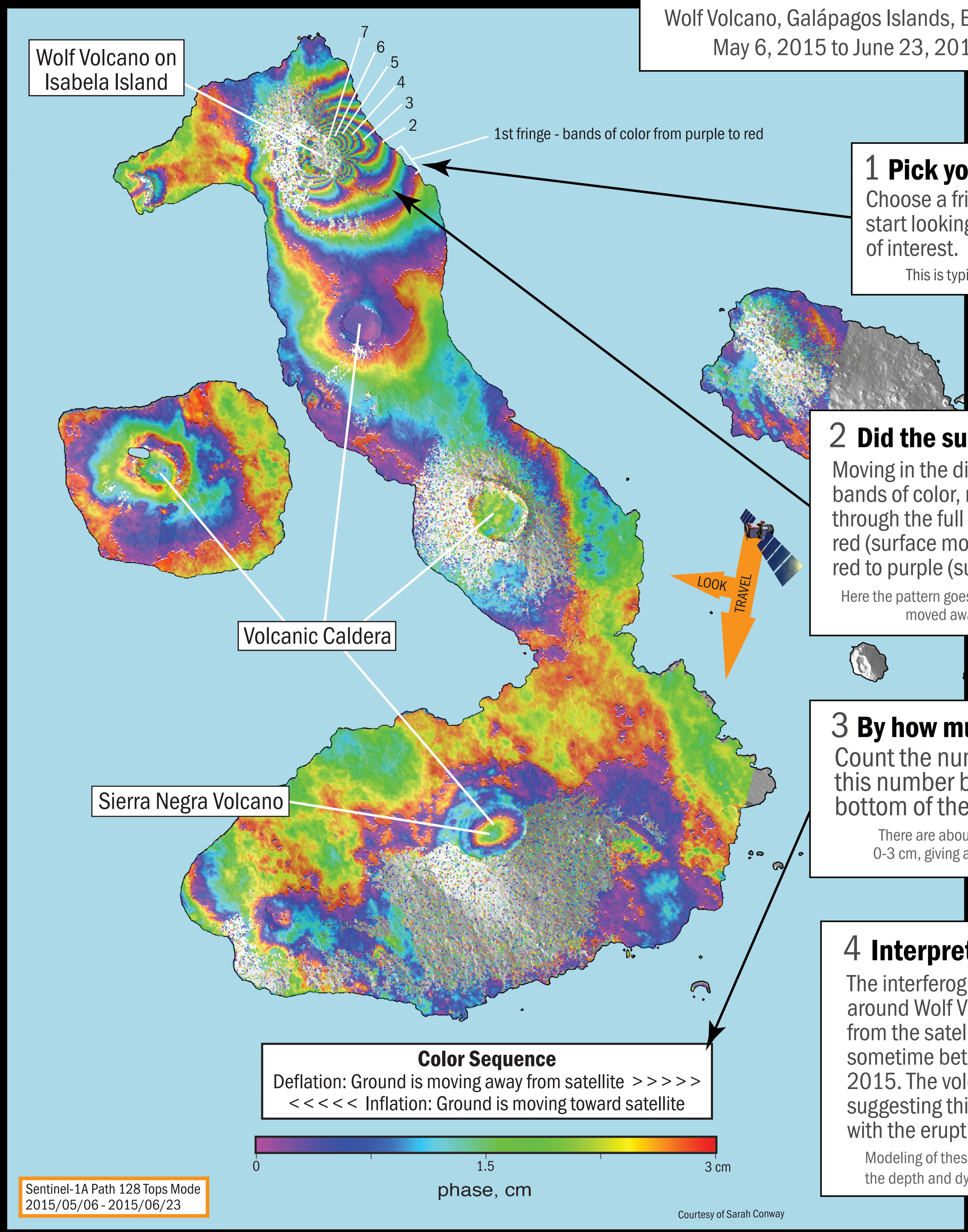
If the ground moved between taking the pictures, the same location on both pictures will have different phase values. Differencing the values produces an interferogram, where changes in Earth's surface appear as color fringes.

What are color fringes?

Think of a fringe as color bands in the visible spectrum—one fringe includes all bands from purple to red.

How to read an interferogram

Wolf Volcano, Galápagos Islands, Ecuador
May 6, 2015 to June 23, 2015



1 Pick your first fringe.
Choose a fringe where bands of color start looking consistent near the area of interest.
This is typically an automated process.

2 Did the surface move up or down?
Moving in the direction of increasingly tighter bands of color, note whether the pattern goes through the full color spectrum from purple to red (surface moved away from the satellite) or red to purple (surface moved toward it).
Here the pattern goes from purple to red, meaning the ground moved away from the satellite - or down.

3 By how much?
Count the number of fringes. Multiply this number by the color scale at the bottom of the interferogram.
There are about 7 1/3 fringes. The scale ranges from 0-3 cm, giving about 21-23 cm of motion at the crater.

4 Interpret
The interferogram shows the ground around Wolf Volcano moved down (away from the satellite) about 22 cm sometime between May 6 and June 23, 2015. The volcano erupted on May 25, suggesting this is deflation associated with the eruption.
Modeling of these data can yield information about the depth and dynamics of the magmatic system.