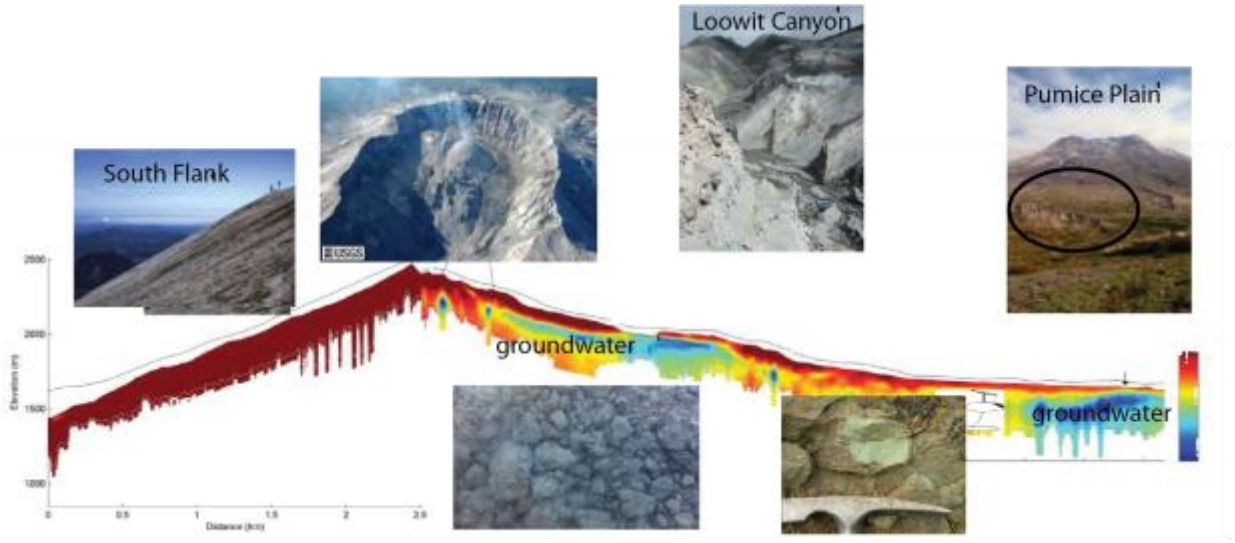
SkyTEM electromagnetic and magnetic survey flying over Spirit Lake, near Mount St. Helens, Washington. Mount Rainier volcano is in the background.

What is Airborne Electromagnetics?

First applied in the 1950's, airborne electromagnetics (AEM) is a geophysical technology that is used to map groundwater resources throughout the world. It measures variations in the electrical conductivity of the ground. Electrical conductivity of rocks and soils is a property that depends on composition and water content. AEM detects geological changes and moisture variations beneath the earth's surface.

How does it work?

Electrical conductivity is measured using a helicopter carrying a suspended large wire loop that houses a sensor and instrument package. The sensor is flown about 100 feet (35 m) above the ground surface. The system transmits weak low-frequency radio waves into the ground to more than 1000 feet (300 m) deep and measures the response that returns from the ground. The surveys are conducted along pre-planned flight paths that follow a "lawn mowing" pattern in order to cover an area as completely as possible. The data collected are processed into slices and 3D images that give scientists a compositional model of the Earth's subsurface (the figure below is an example from Mount St. Helens).



Can EM see magma?

At Yellowstone, molten rock is not found closer to the surface than 3 miles (5 km). This particular experiment is designed to look at much shallower depths of 1000 feet (300 m) or less. Similar techniques can be used to image deeper magma systems, along with seismic, gravity and other techniques that have been applied recently at Yellowstone.

What is the EM survey procedure?

The loop is about 60-feet (20 m) in diameter and weighs about 1000 pounds (450 kg). It is suspended about 100 feet (35 m) below a helicopter, which flies about 200 feet (65 m) above the ground. The helicopter travels an average of 45-75 mph (70 – 120 kph) in closely spaced parallel lines across the area to be mapped. Based at nearby airfields, the helicopter typically departs in the morning and operates during much of the day, weather and flying conditions permitting. It may land in YNP during the day to refuel, but it does not fly at night.

Is airborne electromagnetics a safe technology?

AEM is safely used throughout the world for a variety of geologic studies and in the evaluation of land features and natural resources. The electromagnetic signals generated by this system are considerably weaker than the signals generated by natural and man-made sources (for example, lightning and broadcast radio stations) surrounding us every day. All operations must pass strict government aviation regulations, and the aircraft are flown by specialists who have many decades of experience collecting data in a wide variety of flying environments. The helicopter stays high enough that there is no rotor wash (wind) felt on the ground. It also keeps well above power lines and other obstacles. The survey sensor is securely fastened with a stainless-steel wire rope and a backup Kevlar safety rope. In accordance with FAA safety regulations, the flight paths do not cross over buildings.

Does EM affect wildlife?

The technology causes no ill effects to wildlife, but because low-flying helicopters are involved, there is the potential for animals to be alarmed and briefly disturbed.

Does EM affect electronics or communications equipment?

No, the electromagnetic field generated by the equipment is far too weak to interfere with electronic or communications equipment.

What areas at Yellowstone will be studied using EM?

The study will focus on three main study areas: 1) the Firehole River that includes the Upper and Lower Geyser Basins, including Old Faithful, 2) The Norris Geyser Basin and the faulted valleys between Norris Junction and Mammoth Hot Springs, and 3) the northern end of Yellowstone Lake. In addition, several long single flight lines will cross the entire caldera to provide a regional picture of water distribution in the subsurface.

Upper Geyser Basin seismic survey

How do the portable seismometers work in this survey?

The seismometers that are used in these deployments are small, self-contained systems about the size of a quart jar and cause no disturbance to the ground. Dense grids consisting of 63 to 71 instruments will be deployed for 24 – 48 hours, and then will be moved to a new grid location where it will then run again for 24-48 hours. The grid will keep moving until the whole area of interest is covered. There will be a backbone network of 33 instruments that will run the entire time that can be used to tie the different arrays together.

What type of seismic signals will be recorded?

In addition to recording passive seismic signals (hydrothermal noise, earthquakes, etc.), we will be using a sledgehammer and steel plate to produce seismic signals that will be recorded by the array and can be used to calculate the seismic velocity structure of the area.