Good afternoon, my name is Omar Qureshi and I'll be talking about Induced Polarization method. I'll also talk about one specific application for the IP method.

So to quickly go over the presentation, I'll be discussing what exactly is induced polarization and how it is split into the time domain and the frequency domain. I'll also be discussing a subset of frequency domain induced polarization which is known as spectral induced polarization or spectral IP.

Next we'll get into why even use induced polarization and what benefits it is has over other survey methods.

Then we'll get into formation of porphyry copper and why this specific type of deposit is a good candidate for the IP method. We'll also look into a case study in the Philippines where they used the IP method.

Then I'll wrap up the presentation with some final remarks and go over any questions you may have.

To begin, what exactly is induced polarization method? The IP method is just one type of many electromagnetic survey methods. Essentially what we do is run a current through the subsurface via current electrodes. The charge is then, at times, stored by the subsurface and that is specifically what we are interested in. We measure the overvoltage effect which is what induced polorazation is all about. To go over this diagram briefly, two current electrodes are set that supply charge. Bodies in subsurface are charged and then the two middle potential electrodes are what record that decay.

Time domain IP is essentially measuring how much charge is stored within the subsurface, and how it is gradually dissipated. From this graph, we can see that there is a steady current supplied. After turning it off, instead of just dropping to 0 as you might expect, it follows a decay curve. This is a function of time and with regard to time domain IP, this is what we are interested in.

Frequency domain IP is a little different. We supply currents at two different frequencies to the subsurface. Those then produce voltage waveforms and we compare the transmitted and measured voltage waveform. Because the earth isn't a perfectly homogenous and uniform in matter, there is a phase shift. This measured phase shift gives form to the apparent resistivities.

Spectral IP is essentially a subset of frequency domain IP. Instead of supplying two current frequencies, we apply a broad range of frequencies. This gives us a greater breadth of phase shifts and phase angles, which are again interpreted as apparent resistivities. By apply a greater range of current frequencies, we can also measure a greater range of chargeabilities.

So that kind of gives us a brief background of induced polarization and what it is exactly. The question is, why are we electrocuting rocks? What's the actual purpose? Well it turns out that because of the different physical and chemical properties of the subsurface, it holds onto the charge differently. So now we have certain subsurfaces holding charges in certain different ways, we can then categorize this by areas of interest. Specially with the spectral IP method, we can actually separate out zones of mineralization.

There is also work being done in spectral IP where we are tying the parameters in the equations used to different types of rock bodies. Specifically we are looking into tying coarse and fined grained mineralization into a certain parameter and the uniformity of the grain sizes in a certain medium as another parameter. This is essentially what the figure here shows, different rocks have different phase angels, which show different apparent resistivities.

Now as always in geophysics, its important to remember that there is certain blending. For example, graphite and high concentration porphyry copper give slightly similar signatures. This touches on the ultimate problem in geophysics, nonuniqueness. There are always different models that fit certain data or vice versa so it is important to mention and take note of this.

Now that we know what induced polarization is and how it can be used, let's take a look at a certain type of deposit that might be able to be picked up via induced polarization which is porphyry copper. So to give some preliminary info, porphyry copper is usually found near continental settings. Subduction zone settings provide a good location for these deposits because of igneous intrusions. The magma begins to cool yet the copper remains fluid. This intrusion itself causes contact metamorphism with the country rock and creates zones of alteration. Different zones of alteration vary in physical and chemical property and as such, the Spectral IP method can be used effectively to zone the copper.

Here we are going to go over a case study in the philippines. The Philippines is home to a convergent plate boundary setting so right off the bat we may be able to expect igneous intrsions. Near the Philippines Fault, there were found to be outcrops of copper. When copper has outcrops visible, this is indicative that there may be shallow ores to extract. Especially when the ores are shallow, electromagnetic methods, such as spectral IP, are good candidates for geophysical surveying. And this is essentially what they did, they found an anomalous body of low frequency with that specific survey. This low frequency was thought of as the potassic core, which we know would be highly resitivtive. Because of using spectral IP, we got a broad range of resistivties at different zones of the igneous intrusion alteration zones. As such, this method helped in locating where ore of interest specifically copper could be found.

So this was one case where the IP method was employed effectively.

Now to wrap up, we supply a charge within the subsurface. Because of different physical and chemical properties of the rocks and minerals, they hold onto the at charge different. This can provide us with some preliminary infroatmino on what we may be in the subsurface, especially when gravity and magnetic surveys fail. This is certainly the case in certain types disseminated ores. The IP method can then be used cooperatively with other EM or survey methods to provide a clearer joint solution to the subsurface.