Introduction

Chargeability is a physical property that is related to resistivity. The module about DC resistivity shows that potentials measured in a DC resistivity survey can be related to charges that accumulate when current is made to flow. However, when the transmitter current is switched off, the measured voltage may take up to several seconds to reach zero. Similarly, when the current is switched on, there may be a finite time taken for the voltage to reach a steady state value. In other words, current injected into the ground causes some materials to become polarized. The phenomenon is called induced polarization, and the physical property that is measured is usually called chargeability, which quantifies the material's capacity to retain charges after a forcing current is removed. The following figure illustrates the measurable effect.

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| ./images/IP\_source.gif |

Induced polarization can also be measured using low frequency sinusoidal signals, as discussed in the "Measurements and data" section of this chapter. The signals or data that are measured depend upon which of the various types of source signals are used. Note that IP surveys always include resistivity measurements because the electrical resistivity of the earth must be known in order to invert data to recover chargeability.

# The physical property--chargeability

The materials that are most chargeable include sulfide minerals (both massive and disseminated), clay-rich materials, and graphite. However, the chargeablility of materials can have a wide range within the same geographic region. This is because chargeability depends upon many factors, including mineral type, grain size, the ratio of internal surface area to volume, the properties of electrolytes in pore space, and the physics of interaction between surfaces and fluids.

Interpretation of chargeabililty models is further complicated by the fact that there is no standard set of units for this physical property. There are at least three ways of measuring the phenomenon and models recovered by inversion generally take on the same units as the measurement. This could be milli-seconds if measurements are made of the ground's response to impulsive sources. The units could also be percent if the response at two or more source signal frequencies is compared, or units of milliradians may be used if the phase difference between source and received signals is recorded.

# Typical problems where chargeability is useful

Mineral exploration for sulfides (disseminated and massive) is unquestionably the most common application of IP because those types of ore minerals are often chargeable.There are also applications in hydrogeology. For example, mapping salt water intrusions in aquifers that include clayey layers may be difficult using resistivity alone. However, the increased chargeability associated with clay may help differentiate between zones with more saline water and clay, both of which have low resistivity. In addition, there is a growing interest in the possibility of using chargeability to aid in the detection and delineation of contaminants in the ground. There has also been some effort to apply IP to oil and gas exploration.