Traditionally, self-potential surveys have been carried out in mineral exploration to locate and delineate conductive mineral deposits. These surveys were most successful where a strong oxidation-reduction potential was present in the mineralised body. In addition to conductive mineral deposits, self-potential anomalies may also be attributed to the flow of subsurface fluid or heat.

In the environmental and engineering fields, self-potential surveys are carried out almost exclusively for the detection of seepage through earthen water retention structures such as dams, dikes, reservoir floors, unstable landslide areas and canals. In addition, surveys have been successfully completed to locate structures such as faults, to detect seepage through membranes and to delineate flows around wells and in geothermal areas.

Self-potential or streaming potential anomalies in an earthen structure are caused by fluid flow through the porous medium and ion exchange between the fluid and soil particles within the zone. Related to head difference, fluid resistivity, fluid viscosity and the potential of the electric double layer, these streaming potential effects produce relatively small voltage anomalies that are readily measured at the ground surface, below water in the impoundment area, or in drillholes.

Measurement of these voltages provides information on the location, flow magnitude and the depths and geometries of subsurface flow paths. Negative anomalies occur where seepage enters a structure or flows horizontally with positive anomalies occurring where the flow is generally ascending and surface seepage occurs. Flow path maps are developed that are extremely valuable for planning drillholes and piezometer installations and for remedial measures planning.

Streaming potential surveys have been successfully employed not only to detect anomalous seepage conditions but also to evaluate remedial measures emplaced to control seepage. Pre- and post-grouting surveys in an earthen dam for example, would reveal a change in the magnitude of streaming potentials and provide a means of assessing the effect of grouting operations.

Streaming potential surveys are generally carried out with a fixed base electrode and a roving measuring electrode with station locations determined by pre-surveyed grid, or GPS positioning. Survey procedure consists of traversing the structure and recording individual station readings that are referenced against the fixed base station. Streaming potential profiles or if data density permits, contours in millivolts are produced that are evaluated for anomalous conditions. More recent advances in electronic data acquisition allow for automated operation and recording of streaming potential values with permanent or semi-permanent electrode arrays. Streaming potentials can be measured at frequent, preprogrammed intervals over the entire array which facilitates early recognition of anomalous conditions and provides a means for frequent evaluation of changes in readings at anomalous locations.

The significance of streaming potential anomalies is greatly enhanced by comparison with the detailed geological and hydrogeological data provided by resistivity imaging surveying. This is facilitated through the use of a new electrode design that enables coincident recording of both streaming potential and resistivity data. The addition of a second, complementary geophysical data set provides confirmation of the interpretation and a greater understanding of mechanisms and paths of anomalous seepage flow.