IOCG deposits remain important sources of copper and gold in Australia especially since the discovery of the giant Olympic Dam deposits in 1975. They are considered to be metamorphic expressions of large crustal-scale alteration events driven by intrusive activity and are associated with felsic igneous rocks in most cases, commonly potassic igneous magmatism, with the deposits being commonly ~2.2 –1.5 Ga in age (Harrison, 2009). They tend to be enriched in Cu, Fe, Mn and P, with many deposits exhibiting an additional distinctive enrichment in Fe with economic levels of Cu, Au, Ag, and Rare Earth Elements (REE), and U (Esdale, et al 1994). Such deposits have large net tonnages of economic minerals. Due to these distinguishing features, the IOCG class of deposits is a prime target for exploration by the mining industry. Although IOCG’s are largely classified by their geochemical characteristics many have significant petrophysical contrasts in magnetic susceptibility and/or density. Thus, potential field geophysical methods are typically used to detect both the major structures that lead to the location of prospective targets and the deposits themselves. Such methods have poor resolution at depth, and are limited to either directly detecting shallow targets or very large deposits with sufficient contrast in areas with significant cover, such as the Gawler Craton. Thus, the traditional approaches to exploration for IOCG deposits in the Gawler Craton are becoming less effective and more expensive; hence another method such as seismic reflection is proposed.

Early application of the seismic reflection method in mineral provinces proved relatively expensive and the results were not often encouraging; however, recent research in this area provides greater promise in the ability to delineate ore-bodies and for mine planning in complex hard rock environments (Urosevic et al, 2008). In Australia, especially Western and South Australia, some pioneering work has been done by Greenhalgh et al., (2000) who carried out research on in-mine seismic delineation of mineralization and rock structure at the Kambalda nickel mines and Urosevic et al, (2008), who carried out high resolution surveys in Western Australia to address the lack of information about complex structures and shallow imaging missing from the original 2D regional surveys. In the Canadian shield region Salisbury et al., (2000); Milkereit et al., (1997, 2000) documented the potential of seismic methods for hard rock mineral exploration to a depth range of about 2500m the limit at which modern mining methods are capable of economically extracting ore. Results from three-dimensional (3-D) seismic surveys over goldfields in South Africa (Pretorius et al., 2000) show that under favorable circumstances, where there are large seismic impedance contrasts and flat, sub-horizontal rock units of a great extent, seismic methods are very effective.

Most of the recent work is at mine-scale; larger or regional scale 3D seismic surveys have not been proposed because there has not been a compelling argument of economic benefit to proceed with such work. For the seismic reflection method to be used at these scales (100’s to 1000’s of square km covered) the technical risks or the survey costs have to be lowered. Thus, an important step for adoption in exploration is to demonstrate that IOCG deposits are “discoverable” with sparse 3D seismic reflection techniques. As IOCG deposits have “large footprints” due their association with large scale metamorphism and intrusions we hypothesize that even relatively sparse 3D seismic surveys may be able to pin down the likely areas for exploration under 500-1000m of cover. When such a hypothesis was initially proposed it was thought that the deposits lacked the strong contrasts usually needed, or were too diffuse in their boundaries to provide reflections. However, initial examination of regional 2D seismic lines (by Geoscience Australia) near Olympic Dam and two other deposits provided an indication that prospective areas for exploration drilling for these deposits are identifiable.

To further support our modeling of the seismic response a variety of petrophysical data plus additional 2D and 3D seismic data are underway at different test sites in South Australia, and this data is becoming available for comparative study. Also, there is seismic data already in existence at or near several IOCG deposits such as: Olympic Dam Mine, the Vulcan prospect, the Prominent Hill Mine and the Hillside prospect. From this information we are creating simple, but representative, geological models of IOCG deposit types populated with measured petrophysics. These models are then run with different seismic survey parameters to simulate seismic reflection data, which are then used to predict the geophysical signatures. The seismic signatures created are then compared with the other known geophysical signatures such as magnetic and gravity as well as any existing seismic data. Such analysis will indicate where the seismic reflection method will have greatest impact and benefit plus help determine the role it can play within the existing exploration methodology. The modeling also allows us to see at what point the seismic survey proves to be ineffective, in that is is too sparse to resolve the contrasts.

Our initial analysis of a sub-set of the collected data indicate that large scale seismic surveys could be quite effective as there are distinctive signatures. However, these signatures are not so easily modeled, or what we initially predicted.