Regional crustal structure, fluid and metal transport pathways of Otago illuminated by geophysics

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ABSTRACT

Most minerals research in the Otago Schist has focused on deposit scale and the immediate environs of deposits. This research has been primarily two-dimensional (map-view) and confined to near-surface outcrops and shallow historic mines, although the Macraes mine is now providing some views of the upper kilometre. Geophysical methods can help to increase knowledge of the three-dimensional (3D) structure and rock properties, albeit with lower resolution than direct observations. Recent passive seismic gathered in the southern South Island has provided some new insights on the regional scale structure, fluid content, and rock properties of the schist belt using the 3D distribution of P- and S- seismic wave velocities and attenuation. Major crustal structures are illuminated by the seismic velocity model, and we focus particularly on the northeast side of the schist belt to provide a regional scale context for the structural zone that includes Macraes mine. There is a sharp contrast between schist and greywacke from the surface to ~23 kms depth coinciding with the Hyde-Macraes Shear Zone and Waihemo Fault. The Otago schist is made up of a stack of dehydrated imbricate thrust sheets. A region of recent seismicity, Mw 5.1 Danseys Pass 1998, shows up as a zone of low seismic attenuation to ~8 km depth suggesting that seismic velocity data are imaging zones of enhanced fracturing and fluid flow. It is notable that a similar regional contrast in 3D rock properties can be identified on the southwestern side of the schist belt where it abuts the greywacke terranes of Southland. The current data set is not capable of resolving individual structures, but the technique appears to be potentially useful for regional 3D structural and lithological visualisation if a more closely-spaced set of receivers is used to image a smaller volume of rock than the whole schist belt.