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Ambient noise tomography of Mount Isa, Northern Queensland in Australia

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The Mount Isa region in Northern Australia is a world-class mining complex, yielding significant combined outputs of lead, silver, copper and zinc. This zone consists of sedimentary layers from lower to middle Proterozoic era with a mix of bimodal volcanic rocks and plutonic formations. A significant crustal structure, known as the Gidyea Suture zone, exists within the Mt Isa succession, and its geological history and association with the mineralisation at Mt Isa are unclear. Previous surveys highlighted the distinct geophysical characteristics of region, in terms of magnetic and gravity anomalies, magnetotellurics conductivity anomalies, and structural features from deep seismic refraction. The characteristics of the mid-crustal zone has been implicated in mineralisation models, and imaging mid to deep crustal structures is important for mineral exploration. In this depth zone, passive seismic surveys show apparent advantages due to their low cost and continuous recording, when contrasted with active seismic surveys, or indeed earthquake tomography in this typically low-activity seismic zone. In this study, we use the legacy noise data collected from 53 3-component temporary seismic sensors with 50km spacing covering the Mount Isa area deployed from June 2009 to March 2011, and perform ambient noise tomography (ANT) to model the shear wave velocity (Vs) crustal structure. 681 cross-correlations (CCs) of recordings over two weeks between each pairwise stations are used to calculate the empirical Green's function (EGF) to construct the impulse wavefield. The dispersion curves of the fundamental mode of Rayleigh surface waves are extracted from vertical components of the CCs. Separating the fundamental mode from the other higher modes in the group-velocity map is usually hard to identify. A modified frequency-time analysis (FTAN) based on the global seismology code CPS is used for digitising dispersion curves here. Then the dispersion curve is inverted using a bespoke Markov-Chain Monte Carlo approach to build 1D Vs profiles, which are finally used to construct a 3D shear wave velocity model across the area of interest. We discuss the comparison of the legacy passive seismic data to the results of other geophysical measurements, to provide a new understanding of terrane evolution and crustal structure of Northern Queensland.