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Chlorite as a proximity marker for alteration and Au mineralisation in marine shales of the Roodepoort Formation, Carletonville goldfield, Witwatersrand Basin, South Africa

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The Roodepoort Formation of the Neoarchaean upper West Rand Group in the Carletonville goldfield of the Witwatersrand Basin comprises marine shales that display greenschist-grade metamorphism and hydrothermal alteration dominated by a variety of chlorite-bearing parageneses. Petrographic, XRD and EMP analysis of spatially-constrained samples is linked to high-resolution 3-D seismic imaging to show that chlorite distribution is spatially linked to metre-scale alteration zones associated with a network of brittle-ductile shear zones displaying southward thrust movement. These shears are associated with quartz-calcite-chlorite-pyrite veining. XRF/ICP-MS bulk rock data indicate that gold grade increases from a background of 6.57 ppb to >20 ppb in the alteration zones. In the vicinity of these shear-hosted veins, the metamorphic chlorite (commonly interstratified with muscovite), which forms a peak metamorphic chlorite + calcite + quartz + muscovite $\pm$ pyrite $\pm$ rutile paragenesis, is partially overprinted by hydrothermal chlorite (fine-grained and commonly enclosing other submicroscopic minerals). Mineral chemical results indicate similar compositions for both generations, suggesting chemical equilibration during the hydrothermal event. Both chlorite generations correspond to Fe-rich (Fe/Mg $\geq$ 1.2) Type-I trioctahedral chlorite, however, chlorite Al-content increases from 2.80 and 3.24 apfu in the shear zones. Application of empirical chlorite thermometers shows a range of temperatures (341 to 400 °C), with the most consistent results coming from chlorites with a total Ca + alkalis content <0.2. These values are relatively similar to those obtained from chloritoid-pyrophyllite-bearing regional metamorphic assemblages in the overlying Au-rich Central Rand Group throughout the Witwatersrand Basin. The textural evidence suggests that Au mobility was possible during retrograde shearing; ongoing investigation aims to establish whether this occurred during cooling from the metamorphic peak or represents a separate event. The compositional variation in chlorite noted in this study may provide an additional vector for localised Au-mineralisation in marine shales and other chloritised gold-bearing horizons in the Witwatersrand Supergroup.