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Greenfields exploration for sulphide deposits along the covered tectonic boundary of the Albany-Fraser Orogen and Madura Province, Western Australia

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The Rodona Shear Zone is a wide, northeast trending and southeast dipping tectonic zone interpreted as the suture separating the Proterozoic Madura Province from reworked Archean continental crust of the Albany–Fraser Orogen. The basement rocks are buried beneath 400-500 m of sedimentary cover comprising a Cretaceous succession dominated by marine and non-marine dark carbonaceous shale, siltstone and minor sandstone of the Madura and Loongana formations, unconformably overlain by several successions of Eocene limestone of the Eucla Basin. Assay analyses are unlikely to capture the chemical dispersion of pathfinder elements, such as Cu, Ni, and Zn, from the basement through this thick cover. Conversely, sampling across the Cretaceous and Eocene and Cretaceous-basement unconformities for dense indicator minerals has revealed the presence of numerous grains of detrital pyrite, pyrrhotite, chalcopyrite, pentlandite, sphalerite, cobaltite and Bi-Se tellurides, indicative of the occurrence of prospective sulphide-rich rocks in the region. In addition to the detrital sulphides, diagenetic framboidal pyrite, sphalerite and galena are also observed in the carbonaceous siltstone and sandstones of the Madura Formation. The diagenetic sphalerite consists of 5-10 μm diameter spheroidal aggregates which might refer to the role of sulphate-reducing bacteria in ZnS precipitation. There are variations in the composition of detrital sulphide grains, which are dominated by pentlandite in one area and chalcopyrite in another. The presence of the detrital sulphides also corresponds to the elevated content of Cu and Co near the Cretaceous and Eocene unconformity. Chalcopyrite and pentlandite are relatively soft and may not resist mechanical weathering and transportation. The grains observed in this area have single or composite fabrics and are subangular to angular in shape, which suggests that they may have been transported over short distances and thus could indicate the presence of nearby copper mineralisation. The elevated content of detrital sulphides at the Cretaceous and Eocene unconformity may imply nearby basement paleohighs as the main source of detrital sulphides. Therefore, targeting unconformities for indicator mineral analyses and mapping the relevant paleotopography could be an effective exploration tool to vector towards mineralisation and reduce the cost of deeper drilling.