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Hydrothermal Alteration and Gold Mineralization at the Gruyere Gold Deposit (Yamarna Terrane, Yilgarn Craton, Western Australia)

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The Yamarna terrane is situated at the north-eastern margin of the Yilgarn craton (Western Australia) and is part of the Eastern Goldfields Superterrane (EGST). The largely unexposed terrane encompasses the Yamarna greenstone belt (~2737-2666 Ma) and Dorothy Hills greenstone belt (DHGB; ~2840-2810 Ma). The Gruyere gold deposit (135.54 Mt at 1.31 g/t for 5.73 Moz Au; Gold Road Resources Limited, ASX Announcement 15-02-2021), mined since 2019, is the eastern-most gold mine of the EGST and is situated within the DHGB at an inflection in the regional-scale Dorothy Hills shear zone. Only limited geological investigations were conducted on the evolution of the Gruyere gold deposit. Therefore, it is unclear if gold mineralization was part of an early (orogenic and/or intrusion-related?) mineralization and deformation event at ~2810 Ma, or whether mineralization was part of the younger mineralization event at ~2665-2620 Ma that gave rise to widespread gold mineralization in the EGST.

Gold mineralization in the Gruyere gold deposit is hosted by the Gruyere granitic intrusion (GYI; 2834 ± 3 Ma; U-Pb on zircon using LA-ICP-MS). The steeply east-dipping GYI intrudes tholeiitic, low-Th meta-basalts to the east and intermediate to mafic volcanoclastic rocks to the west. Numerous steeply ENE-dipping, post-mineralization, mafic dikes (<5 m width) intrude the DHGB sequence.

Hydrothermal alteration associated with gold mineralization of the GYI can be subdivided into three alteration zones. The distal alteration zone (<1.0 g/t Au) is pervasive with a steeply ENE-dipping foliation, and consists of a dark-green, biotite-chlorite ± albite ± sericite ± carbonate ± pyrite assemblage. The intermediate alteration zone (0.5-3.0 g/t Au) has a distinct feldspar-porphyritic texture and consists of a beige albite-biotite-chlorite ± sericite ± carbonate ± pyrite ± pyrrhotite ± arsenopyrite ± gold assemblage. Tabular quartz-veins with slip-fibre textures, which are striking subparallel to the earlier biotite-foliation, are characteristic for the intermediate zone. These quartz ± albite veins have distinct chlorite-biotite selvages with pyrite-pyrrhotite ± arsenopyrite ± galena ± chalcopyrite ± gold ± electrum ± telluride assemblages. The proximal alteration zone (>2.0 g/t Au; <5 m width) shows complete obliteration of the igneous textures, and consists of a yellow-beige sericite-albite ± biotite ± chlorite ± pyrite ± arsenopyrite ± pyrrhotite ± gold ± electrum ± telluride assemblage. Massive, irregular quartz-veins with granitic wall-rock slivers crosscut the tabular quartz-veins and are characteristic for the proximal zone. Sulphide-gold assemblages of the proximal zone are predominantly located within altered granitic slivers and are in equilibrium with biotite-chlorite assemblages within the irregular quartz-veins. Accessory minerals such as rutile, ilmenite, apatite, monazite, xenotime, and zircon are in many places observed at the vein selvages, and share common grain boundaries with pyrite, arsenopyrite, and gold. These equilibrium assemblages suggest a hydrothermal origin of the accessory minerals.

Further geochemical work is ongoing to constrain the precise gold mineralization age. The age of the Gruyere intrusion will then be compared to the age of gold mineralization in order to constrain a robust genetic model that can be used for exploration targeting of concealed gold mineralization in the Yamarna terrane.