Regional targeting criteria for gold in the Yilgarn Craton: which ones work and how well?

by

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Regional targeting criteria for gold in the Yilgarn Craton have been described and assessed using GIS spatial analysis, as part of the Yilgarn Gold Exploration Targeting Atlas, a collaborative project involving the Geological Survey of Western Australia (GSWA), the Centre for Exploration Targeting (CET), and several industry groups. These spatial analyses made use of GSWA's 1:500 000 interpreted bedrock geology shape files, legacy shape files inherited from the pmd*CRC, and Barrick Gold Corporation's gold deposit database. Twelve groups of containment analyses, and ten groups of proximity analyses, have been completed, and these form the basis of the results presented here. In proximity analyses, gold endowment (expressed in various forms) is plotted against buffer distance. Curves that peak in proximal buffers and decline with increasing buffer distance are interpreted to indicate a good relationship between gold abundance and the criterion under assessment. Erratic curves, and those in which gold endowment increases with increasing buffer distance, are regarded as poor targeting criteria for gold. The analyses have been variously carried out at the scale of the Yilgarn Craton, of individual provinces, or at the subprovince scale (superterrane, terrane, or domain), depending on the extent and reliability of the input data. Consistency of results between the eastern Yilgarn Craton, the central Yilgarn Craton, and the Murchison Domain in the northwestern Yilgarn Craton contributes to confidence in the results, especially where results are heavily influenced by a single deposit, such as the Golden Mile in the eastern Yilgarn Craton.

The most successful of the targeting criteria tested so far are: i) proximity to Mafic Group granitic intrusions; ii) proximity to regional faults and regional fault bends; and iii) regional fault density. Other useful criteria include: the presence of low-pressure, lower-greenschist M2 metamorphic domains; intermediate (3–5 km) greenstone thicknesses; vergence anomalies defined by regional faults; and late-stage basins. Other targeting criteria — including proximity to domes, regional strain partitioning, samarium–neodymium basement terranes, constriction zones, tomographic edges, and raw aeromagnetic and gravity worms — result in a greater chance of success than random exploration, but provide limited benefit to explorers compared to those previously listed criteria.

The targeting criterion producing the best results for gold exploration in the Yilgarn Craton is proximity to Mafic Group granitic rocks (Figs 1 and 2a). A 1 km buffer created around these intrusions captures 43.1% of the gold endowment (17.7% of deposits) in 0.85% of the area (a percentage endowment / percentage area (%endowment/%area) ratio of 50.4). Restricting the analysis to the Kalgoorlie and Kurnalpi Terranes of the eastern Yilgarn Craton results in a lower (but still very satisfactory) %endowment/%area ratio of 28.4. This result suggests a very strong relationship between gold and Mafic Group intrusions in the Murchison Domain (there are no Mafic Group granites documented in the central Yilgarn Craton, which is broadly equivalent to the Southern Cross Domain). Although lamprophyres are common in Archean gold deposits (Rock et al., 1989), by including lamprophyres with the Mafic Group granites in the Kalgoorlie plus Kurnalpi Terranes analysis, the %endowment/%area ratio is reduced to 11.3 (still a very good result). Note that the endowment versus buffer distance curves for Mafic Group granites (Fig. 2a) conform to that anticipated for a strong positive relationship between gold and proximity to Mafic Group granitic rocks, whereas the curves for High-Ca granitic rocks and Low-Ca granitic rocks do not.

Proximity analyses relating gold to regional faults produced the best results with a 1 – 1.5 km buffer. Results in terms of %endowment/%area are 5.90 (eastern Yilgarn Craton), 5.40 (central Yilgarn Craton), and 4.92 (Murchison Domain). Fault bends on the regional faults were generated digitally and these provided even better results, ranging from 49.0 for the central Yilgarn Craton, to 11.90 for the eastern Yilgarn Craton. Regional fault density was calculated, gridded, and contoured, resulting in seven to ten fault density bins. The resulting containment analyses relating gold to fault density produced a spectacular %endowment/%area ratio of 108.90 for the eastern Yilgarn Craton, but confidence in this result is tempered by the dominating effect of the Golden Mile. Results for the Murchison Domain (%endowment/%area ratio of 20.74) and central Yilgarn Craton (%endowment/%area ratio of 8.34) are considered more reliable.

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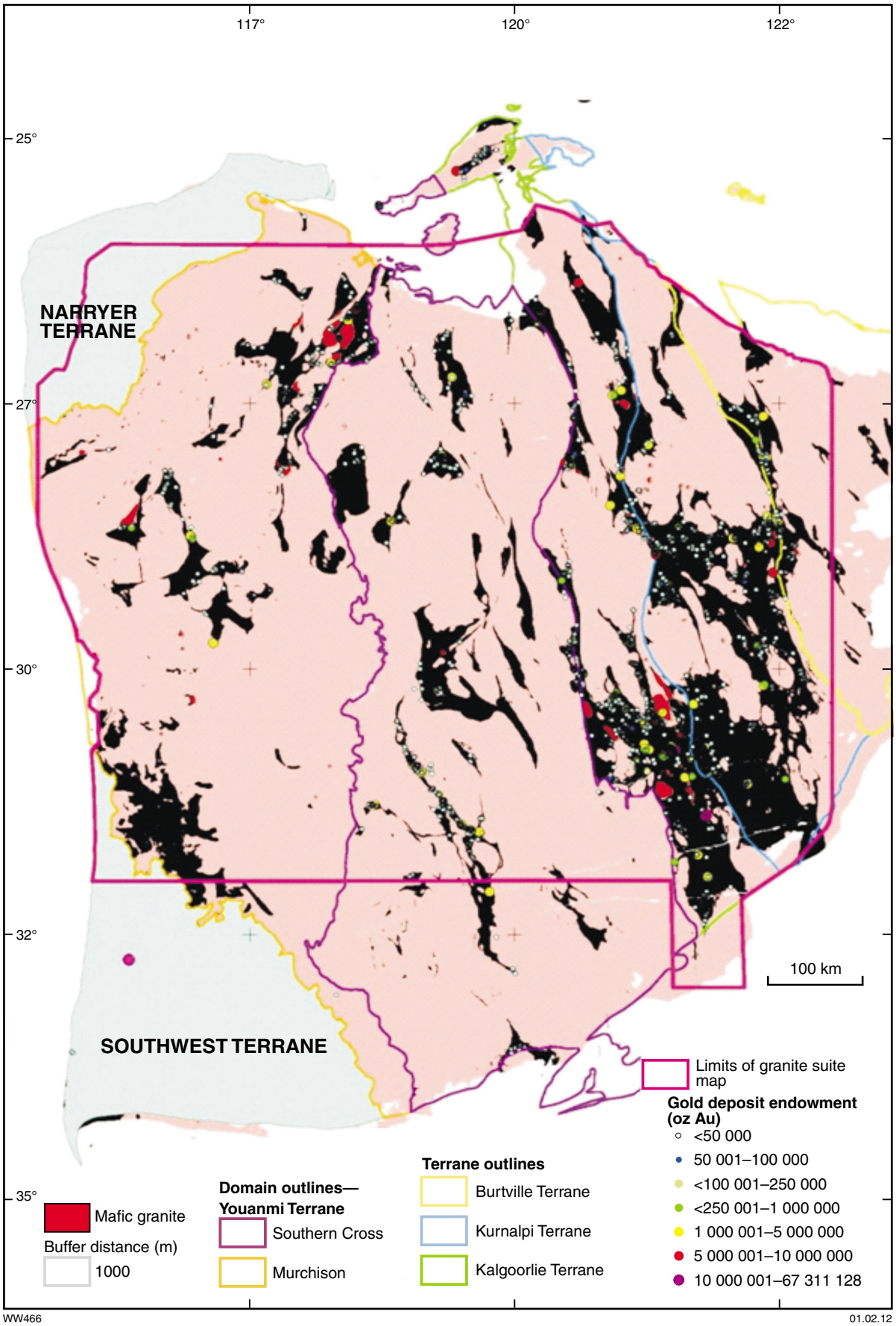

Figure 1. Map of the Yilgarn Craton, showing the distribution of gold deposits, and Mafic Group granites with 1000 m buffers

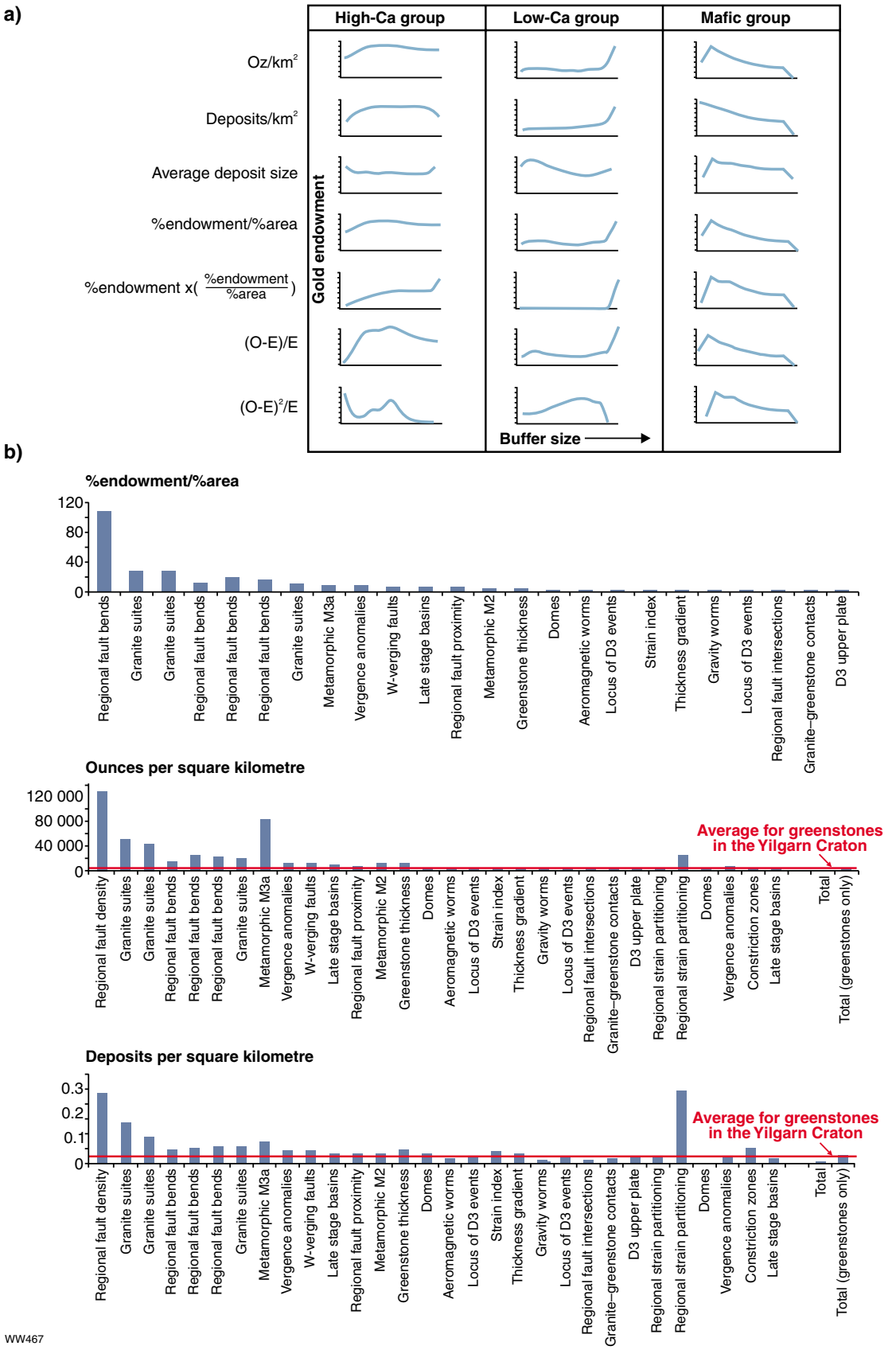

Figure 2. ***a) Tabulated results and curves relating gold endowment to buffers of various sizes, for High-Ca, Low-Ca, and Mafic Group granitoids, Yilgarn Craton. O represents the observed number of gold deposits or gold endowment (in ounces); E represents the expected number of gold deposits or gold endowment (in ounces); b) results of GIS spatial analyses, eastern Yilgarn Craton, ranked in terms of %endowment/%area for the most effective buffers***

Summary results of the GIS spatial analyses for the eastern Yilgarn Craton, the most data-rich area, are presented in Figure 2b, where the various targeting criteria are ranked in terms of %endowment/%area ratio, ounces of gold per square kilometre, and gold deposits per square kilometre. The analysis areas included both granites and greenstones in the eastern Yilgarn Craton. Those criteria that yielded less than the average ounces per square kilometre, or less than the average deposits per square kilometre for greenstones in the Eastern Yilgarn Craton (the red lines in Figure 2b), are considered to provide incremental benefit to explorers.

Ongoing work on the Yilgarn Gold Exploration Targeting Atlas covers exploration targeting and vectoring methods at both the district and deposit scales. At these larger scales, there is less of an emphasis on GIS spatial analysis, and a greater focus on case histories. This project is scheduled to be completed in May 2012, and the results will be freely available from the DMP website once GSWA publication processes have been completed.

References

Rock, NMS, Groves, DI, Perring, CS and Golding, SD 1989, Gold, lamprophyres and porphyries: what does their association mean?, *in* The Geology of Gold Deposits: the perspective in 1988 *edited by* RR Keayes, WRH Ramsay, and DI Groves: Economic Geology, Monograph 6, p. 609–625.