



Dispersion of gold and other metals by trees, gravels and soils near Boddington Gold Deposit, Western Australia



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A B S T R A C T

South west Western Australia is host to some of the world's largest mineral deposits including bauxite, Ta and Au. The giant Boddington Gold Mine exploits one such deposit and is located in forested areas south east of Perth. Exploration for Au in this area has concentrated on sampling surficial Fe-rich lateritic residuum and its degradation products and was how Boddington was originally discovered; it has a multi-element signature. Despite its location in forest there has been little biogeochemistry undertaken in this area or consideration of whether trees (including eucalypts) are agents of dispersion of metals in this terrain. Eucalyptus trees have been shown to be responsible for forming anomalies above gold deposits in semi-arid areas of Australia and the location of Boddington in a humid environment provided an important comparison in which to investigate this possibility.

The Golden Triangle Au prospect near Boddington Gold Deposit is located on the flank of a small lateritic hill. Limited shallow drilling has identified sub-economic mineralisation with some metre composite cuttings grading > 1 ppm Au. A selection of different trees and shrubs, organic soil and ferruginous pisoliths were collected over a surface traverse of 800 m at 50 m intervals from across the prospect. Samples were analysed for major elements, Au and several pathfinder metals. Additional foliage samples were collected from the same trees over mineralisation and background to test for sample heterogeneity.

Golden Triangle vegetation samples were generally anomalous in Au and pathfinder elements (e.g. Ag, Bi, W and Sn). For example, *Banksia* and *Macrozamia* had elemental anomalies in Bi and Ag located directly above or down slope of mineralisation although for *Eucalyptus* the anomaly over mineralisation itself was poorly defined. Topsoil containing organic matter overlying the ferruginous pisoliths was particularly anomalous in Au (mean of 47 ppb against of background of < 5 ppb). Pathfinder element anomalies were present in all sample media (soil, vegetation and pisoliths) although the specific elements and tenor of the anomaly varied between sample media.

The results demonstrate a biotic (plant) influence on the dispersion of metallic elements at Golden Triangle prospect. This process of dispersion may serve to not only disperse and dilute metals in the regolith but potentially create a larger exploration target to detect the presence of the mineralisation. The anomalous metal content of the pisoliths themselves may be due to an earlier biotic mechanism of metal mobilisation from the deeper regolith or be solely a result of inorganic processes as previously thought. The sampling of deep-rooted trees and soil beneath them may assist in the discovery of mineral deposits in areas where there is transported material or leached regolith.

1. Introduction

The general study area is located in the SW of Western Australia in *Eucalyptus* forests that host many significant mineral deposits such as Boddington Au deposit, Greenbushes Sn and Ta, and Darling Range bauxite. The Boddington Gold Mine is located 100 km SE of Perth. The Golden Triangle prospect study site is located 2 km east of the Boddington Gold Mine in a relatively undisturbed part of the forest.

Limited drilling has outlined sub-economic Au mineralisation located within a few metres of the surface. Data on the detailed geology and mineralisation prospectivity were not available due to the minimal exploration activities in the area. In this study, we sampled and compared a variety of different trees, topsoil containing organic material (“organic soils”) and pisoliths along a single transect over the Golden Triangle mineralisation and into background areas. Unusually for Western Australia, the Boddington Deposit is relatively isolated as the

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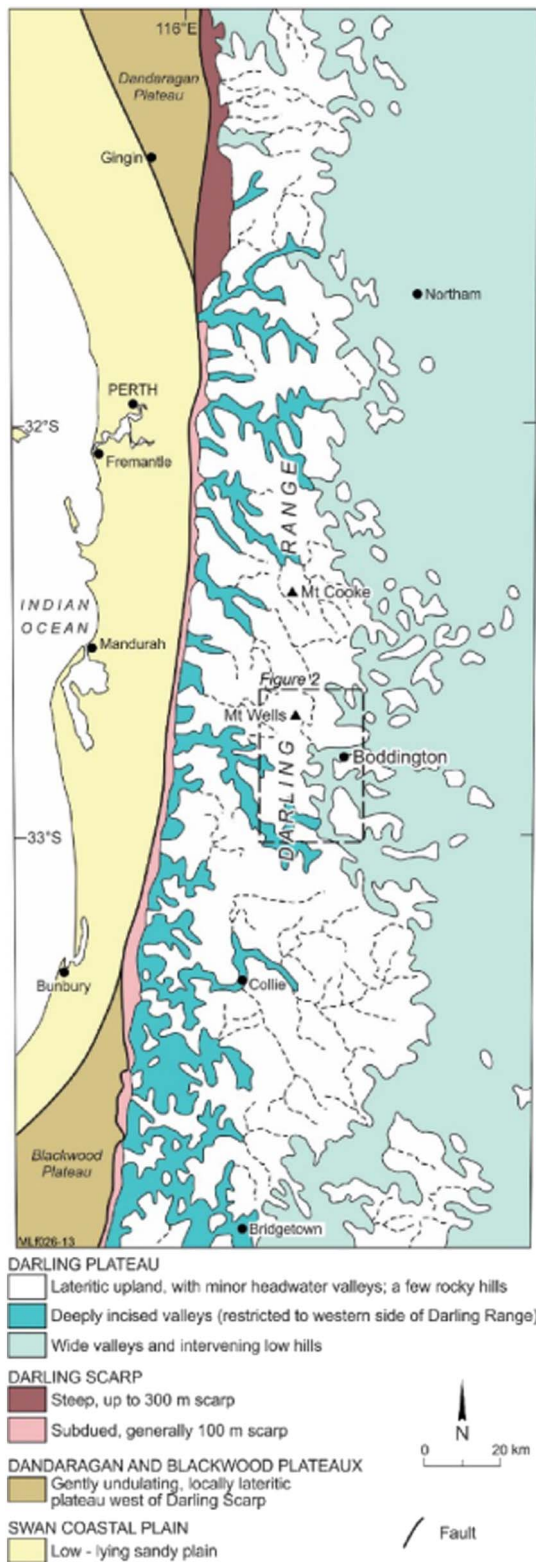


Fig. 1. Location of the Boddington Gold Mine in the Darling Range (Western Australia) (after Hickman et al., 1992). Boxed area shows location of Fig. 2.

only large Au occurrence in this area and thus further potential remains for other deposits to be present.

The Boddington Gold Mine competes with the Super Pit in Kalgoorlie for the title of Australia's largest Au mine. In 2010, the mine had reserves of 20 M oz of Au and > 1 M tonnes of Cu (Newmont, 2013). Copper supplies up to one third of the revenue of the Boddington

Gold Mine and is therefore a significant component of the mineralisation. It is located towards the eastern edge of the Darling Range about 100 km SE of Perth (Western Australia, Fig. 1) beneath a deeply and variably weathered, undulating landscape ranging from 250 to 400 m asl. Local relief is about 50 m, with shallow valley floors adjacent to smooth, broadly convex crests. Larger hills such as Mt. Wells and Mt. Cooke, project above the dissected plateau to 500–600 m asl.

The climate has wet cool winters and hot dry summers with an average annual rainfall of ~800 mm; mean temperature ranges are 14–32 °C (January) and 4–15 °C (July) (Australian Bureau of Meteorology, 2016). The dominant vegetation type is a *Eucalyptus* and *Corymbia* forest, a middle story dominated by *Persoonia*, *Banksia*, *Xanthorrhoea*, *Macrozamia* and *Casuarina*, and an understorey of various shrubs, herbs and grasses (Beard, 2015).

2. Geology

The Boddington Gold Mine lies within the northern part of the Archaean Saddleback greenstone belt of the South West Terrane, Yilgarn Craton, a steeply-dipping and extensively faulted sequence of greenschist to lower amphibolite metamorphosed sedimentary, felsic, and mafic volcanic and pyroclastic rocks, which have been extensively faulted (Fig. 2; Davy, 1979). The Boddington deposit is adjacent to a NW-trending lineament that, at mine-scale, forms a shear zone along the western margin of the mineralisation. Bedrock near the mine is felsic and mafic andesite to the east and schists to the west. The primary Au mineralisation is hosted in intermediate to felsic volcanic rocks. It is a low-sulphide system with intense silicification, potassic and calc-silicate alteration, and a distinct Au-Cu-Mo-W-(Bi) association (Symons

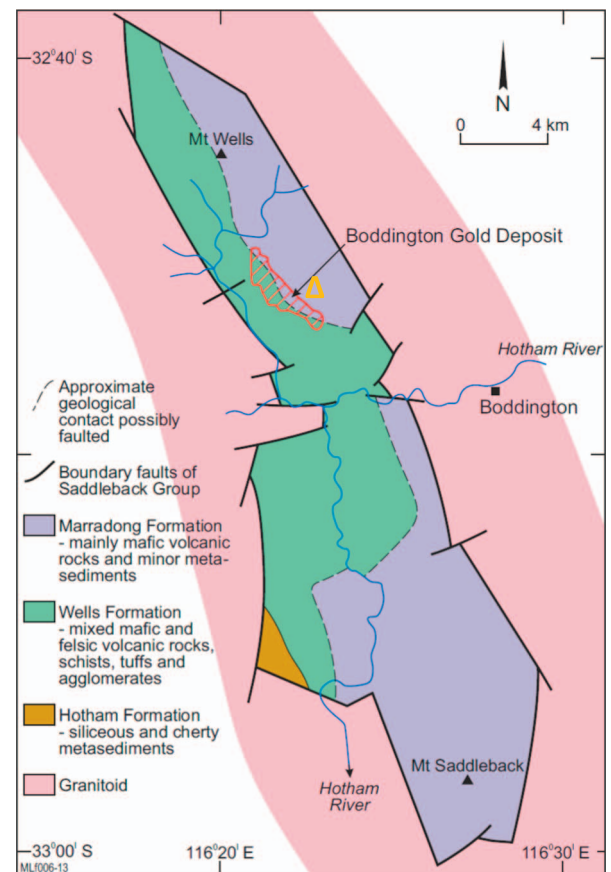


Fig. 2. Geology of the Boddington Gold Deposit and surrounding area (after Wilde and Low, 1980). The Golden Triangle (shown as triangle) prospect is located 2 km east of the Boddington Gold Deposit. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

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