Ore Geology Reviews 51 (2013) 79–92

Contents lists available at SciVerse ScienceDirect

Ore Geology Reviews

journal homepage: www.elsevier.com/locate/oregeorev

The West Jordan deposit, a newly-discovered type 2 dunite-hosted nickel sulphide system in the northern Agnew–Wiluna belt, Western Australia

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ARTICLE INFO

Article history:
Received 18 September 2012
Received in revised form 5 December 2012
Accepted 14 December 2012
Available online 22 December 2012

Keywords:
Nickel sulphide
Agnew–Wiluna
Ultramafic
West Jordan

ABSTRACT

The West Jordan nickel deposit, in the northern Agnew–Wiluna greenstone belt of Western Australia, is a newly-discovered Type 2 dunite-hosted, low-grade, large tonnage, disseminated sulphide system. Located in the core of a large dunite body, mineralisation is dominated by intercumulus sulphide blebs (20 μm to 6 mm across) in assemblages containing pentlandite, pyrrhotite, heazlewoodite and locally, native nickel, sphalerite and chalcocite. Mineralisation grades between 0.2 and 2 wt.% Ni, with the majority of samples in the 0.35–0.7% Ni range, were consistent with most komatiitic Type 2 systems. Hypogene alteration of the ultramafic host rock is interpreted to have been effected by retrograde metamorphic fluids, and has resulted in extensive serpentinisation and localised, structurally-controlled, talc-magnesite alteration. This gangue alteration has resulted in modification of original magmatic sulphide assemblages, and localised remobilisation of the minor Cu and Zn components of the magmatic sulphides. The deposit is deeply weathered, and all samples utilised in this study were obtained from a series of 12 diamond drill holes which were comprehensively assayed. An igneous stratigraphy is presented which is interpreted to be west-younging, consistent with along-strike deposits to the south, such as the Mount Keith and Yakabindie Type 2 nickel deposits.

1. Introduction

West Jordan is a newly-discovered, Type 2 dunite-hosted, low-grade, disseminated nickel sulphide deposit, located 52 km south-east of Wiluna in the Albion Downs domain, northern Agnew–Wiluna greenstone belt, Yilgarn Craton, Western Australia (Fig. 1). It represents a large tonnage, low-grade sulphide resource of the style typified by well-defined deposits in the same region, such as Mount Keith (Barnes et al., 2011; Grguric et al., 2006), Yakabindie (Grguric et al., 2006; Hill, 1982; Naldrett and Turner, 1977) and several of the Honeymoon Well deposits (Donaldson and Bromley, 1981; Gole and Woodhouse, 2000). Type 2 deposits are considered economically attractive from the point of view of their typically large size (10 s to 100 s of Mt), and the ability to generate high-grade concentrates (>18% Ni) from their ores, using conventional froth flotation processing technology (Grguric and Riley, 2006).

Small quantities of disseminated Ni sulphides had previously been intersected in drill holes in the Jordan area of the Albion Downs domain (e.g. see Fiorentini et al., 2007), however, none of these occurrences were of economic significance. In July 2009, Norilsk Nickel Australia drilled a single diamond drill hole (09NADD0001), targeting the core of the serpentinised dunite body at the West Jordan prospect. This drill hole intersected 73 m at 0.62% Ni, as disseminated sulphides, from 263 m down hole. A follow-up hole, drilled 400 m to the north in 2010, intersected 168.5 m at 0.61% Ni, leading to a concerted exploration effort from late-2010 to mid-2011, during which 10 diamond holes were drilled on 100 m-spaced sections for a total of 7010 m. Disseminated nickel sulphide mineralisation was intersected in all 10 holes, and drilling to date has delineated a body of mineralisation, continuous over a strike length of 700 m (Fig. 1), and down to a vertical depth of 600 m (Fig. 2). The average grade of the mineralisation is 0.58% Ni.

This paper presents the geology, mineralogy and interpreted genesis of the West Jordan deposit, utilising the complete drill hole dataset comprising 8148 m of diamond core.

2. Regional geological setting

The Agnew–Wiluna belt is an Archaean greenstone sequence, dominated by basaltic and felsic volcanics and volcaniclastics, komatiites, large cumulate ultramafic bodies of komatiitic affinity, and minor chemical and clastic sedimentary rocks (Barnes et al., 2011; Beresford et al., 2004; Hill et al., 1990). The belt forms part of the northern section of the Kalgoorlie Terrane in the Yilgarn Craton, and is dominated by rocks of 2.7 Ga age (Cassidy et al., 2006). In the West Jordan area, which forms part of the Albion Downs domain (Fiorentini et al., 2007), the belt trends in a north–northwest to south–southeast direction and is bound

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http://dx.doi.org/10.1016/j.oregeorev.2012.12.003

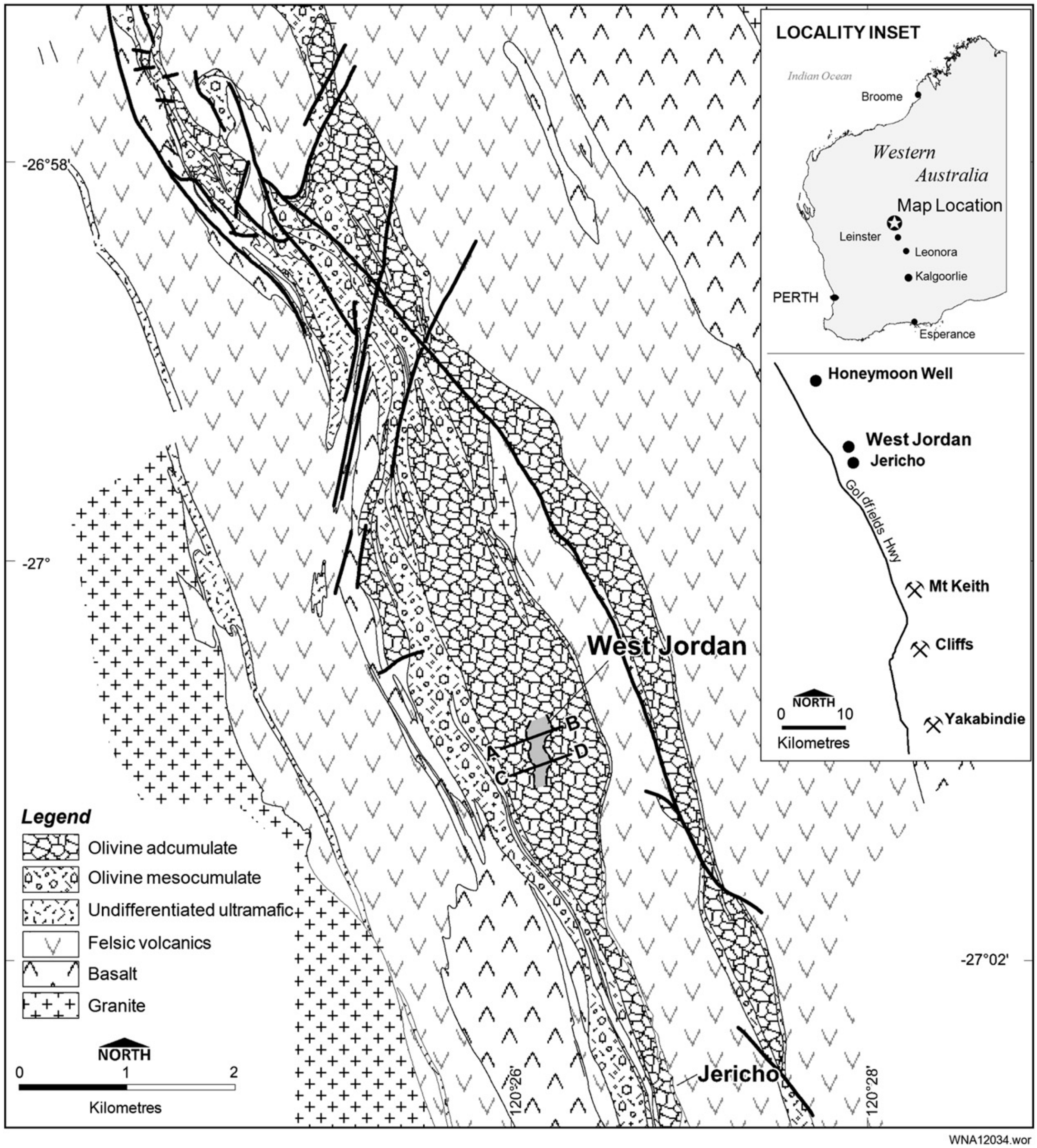

Fig. 1. Location and geological setting of the West Jordan deposit in the northern Agnew–Wiluna greenstone belt, Western Australia. Surface projection of mineralisation is show in grey, together with locations of cross sections shown in Fig. 2.

by large terrane-scale faults and Archaean granitoid bodies (Fig. 1). The greenstone sequence underwent polyphase deformation involving;

D1: A north–south-directed shortening resulting in tight to isoclinal folding, and north over south reverse faulting.

D2: Regional east–west shortening resulting in north–northwest-trending, open to tight high-amplitude folds and the local development of axial planar schistosity. Regional peak metamorphism was penecontemporaneous with D2 deformation (ca. 2.680 to 2.665 Ga) with P,T conditions reaching lower greenschist facies in the West Jordan area (Goscombe et al., 2009).

D3: Lithospheric extension, possibly associated with lower crustal delamination, resulting in extensional doming and northeast-directed extension (Czarnota et al., 2010).

D4: Continued east–west shortening resulting in strike–slip faults and shears (Duuring et al., 2004).

The retrograde phase of metamorphism in the northern Agnew–Wiluna belt was associated with regional metasomatism, dominated by epithermal to mesothermal H_2O–CO_2 fluids of interpreted metamorphic origin (Phillips and Groves, 1983). As well as gold mineralisation, these fluids are interpreted to be responsible for extensive serpentinisation and structurally-controlled (D4) talc-carbonate alteration of the ultramafic sequences in the belt (Rödsjö, 1999).

The northern section of the Agnew–Wiluna belt is host to significant gold and nickel deposits, including the 5 million ounce Wiluna gold camp (Hagemann et al., 1992), and the ultramafic-hosted Mount Keith, Yakabindie, and Honeymoon Well nickel sulphide deposits (Fig. 1), which together contained (pre-mining) a total of 5.5Mt Ni