Ore Geology Reviews 36 (2009) 350–362

Contents lists available at ScienceDirect

Ore Geology Reviews

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

Geochronological and isotopic constraints on Palaeoproterozoic skarn base metal mineralisation in the central Gawler Craton, South Australia

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ARTICLE INFO

Article history:
Received 1 August 2008
Received in revised form 4 September 2009
Accepted 4 September 2009
Available online 15 September 2009

Keywords:
Skarn
Palaeoproterozoic
Gawler Craton
Geochronology

ABSTRACT

The mineralisation potential of Palaeoproterozoic strata from the central Gawler Craton, South Australia, is poorly known. This study defines the timing of Zn-rich skarn formation within Palaeoproterozoic calcsilicate and highlights this as a new mineralisation style for the Gawler Craton. Sulphides within the garnet–diopside skarn in the No. 17 Bore Prospect are predominantly in the form of sphalerite, associated with galena, minor chalcopyrite, pyrrhotite and pyrite. Sulphide is present in disseminated form and as a coarse-grained sulphide within a sericite-rich cavity-fill. Mineralisation is inferred to have formed at 1710 ± 16 Ma through a Sm–Nd isochron from garnet and diopside aliquots. A weakly mineralised and altered granite immediately below the calcsilicate skarn crystallised at 1729 ± 13 Ma (LA-ICPMS U–Pb zircon), within error of the skarn mineralisation. The skarn is interpreted to have formed through the initiation of fluid circulation as a result of high-level granite emplacement within the Palaeoproterozoic strata. Exploration for skarn Zn–Pb deposits such as the No. 17 Bore Prospect is assisted by their geophysical properties.

1. Introduction

The key ingredients for most economically important skarn deposits are the presence of an igneous intrusion to generate hydrothermal fluid circulation and possibly provide a source for the metals, along with a suitably reactive country rock, typically carbonate (e.g., Meinert, 1992). The Gawler Craton, South Australia, has an abundance of both of these ingredients with voluminous magmatic events spanning the interval ~1850 to 1575 Ma and widespread carbonate within Archaean and Palaeoproterozoic sedimentary packages across the Gawler Craton (Parker et al., 1993; Daly et al., 1998). Nevertheless, the Gawler Craton is best known as host to a number of significant Mesoproterozoic, c.1595 Ma, iron oxide–copper–gold (IOCG) deposits and prospects, such as Olympic Dam and Prominent Hill (Skirrow et al., 2007 and references therein; Fig. 1). Olympic Dam-style, Mesoproterozoic IOCG targets are naturally the focus for many mineral explorers within the Gawler Craton and few have actively targeted skarn-type mineralisation. Here we present petrographic, geochronological, geochemical and isotopic constraints on the origin and timing of a newly discovered example of skarn-related Zn–Pb–Ag mineralisation at the No. 17 Bore Prospect, located within the central Gawler Craton (Fig. 1). The No. 17 Bore Prospect represents an example of skarn-related mineralisation which currently receives little attention from explorers, despite the potential for this type of base metal target in the Gawler Craton.

2. Geological setting

Rock types in the central Gawler Craton cover the full range of Gawler Craton geology, from the Archaean through to the Mesoproterozoic (Figs. 1 and 2). The recent discovery of Mesoarchean basement in the southern Gawler Craton (Fraser et al., 2008) raises the possibility that similar basement may also exist in the central Gawler Craton (Daly and Fanning 1993); however, there is at present no geochronological evidence for components of this age. The oldest exposed rocks in the central Gawler Craton are a Late Archaean to earliest Palaeoproterozoic (c.2560 to 2440 Ma) package of metavolcanics, metasediments and syntectonic intrusives termed the Mulgathing Complex (Daly and Fanning, 1993), which includes the komatiite-hosting Harris Greenstone Belt (Hoatson et al., 2005). The Mulgathing Complex was deformed and metamorphosed during the earliest Palaeoproterozoic Sleafordian Orogeny (2460 to 2420 Ma; Fanning et al., 2007).

Palaeoproterozoic sedimentary sequences dominate the rock record in the central Gawler Craton; however, exposure is poor and there are few direct geochronological constraints on the age of these units. The oldest unit recognised, the Wilgena Hill Jaspilite, is a finely

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doi:10.1016/j.oregeorev.2009.09.001

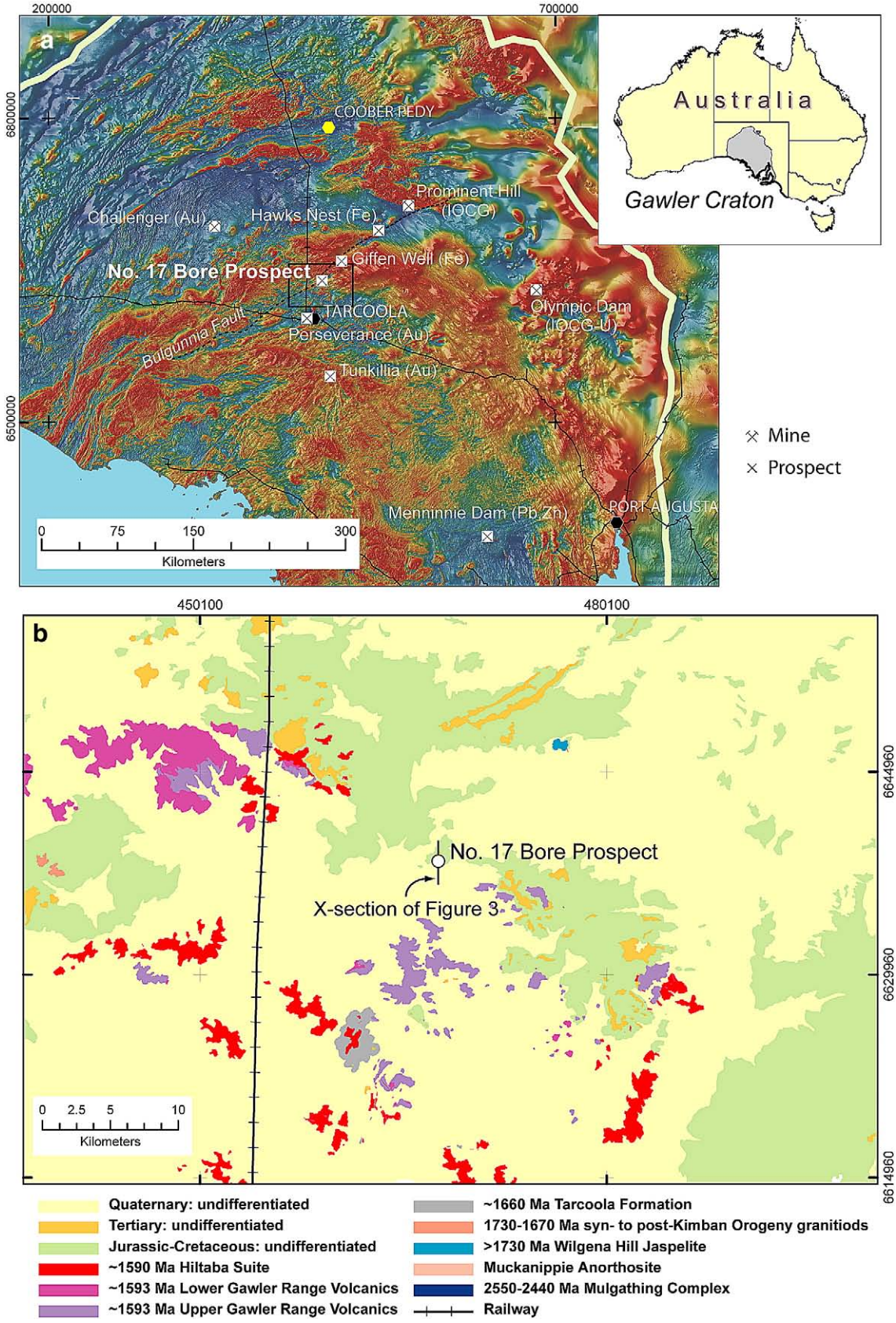

Fig. 1. Location of the No. 17 Bore prospect within the central Gawler Craton, South Australia. a. Location of the No. 17 Bore prospect along with major mines and mineral deposits of the region superimposed on regional total magnetic intensity image (PIRSA data). The Bulgunnia Fault, a major crustal scale fault/shear structure located adjacent the No. 17 Bore prospect is also shown. Mine and prospect commodities given in brackets, where IOCG-U indicates iron oxide–copper–gold–uranium mineralisation, as at Olympic Dam. b. Outcrop geology for the region around the No. 17 Bore Prospect. Location of this map is shown by rectangle in a. Coordinate system for both maps is GDA 1994, MGA Zone 53.