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THE TECTOGENESIS OF THE TELFER GOLD-COPPER ORE SYSTEM IN THE PROTEROZOIC PATERSON OROGEN, NORTH WESTERN AUSTRALIA

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Abstract: This paper reviews the tectonic genesis of the Telfer Au-Cu ore system in the Paterson Orogen, NW Australia. Most previous tectonic interpretations have focused on the regional compression-related tectonic processes. These interpretations, however, could neither explain the tectonic deformation nor the distribution of mineralisation. Tectogenetic analysis indicates that the Telfer deposit comprises two overlapping structural domains, both developed as a result of the upward propagation of basement fractures. The first domain represents a local compression-shear-related regime that initiated tectonic deformation and tectonic shortening of the host rock. This regime had a limited role in the mineralising processes. The second, more important regime for mineralisation control, is associated with local shear-extensional tectonic processes. At deposit scale, concurrent development of a normal dip-slip movement along the earlier formed bedding surfaces and the basement propagated steep reverse-slip shearing along NW–SE (S2) trending structures, parallel to the strike of the Paterson Orogen, are the most important tectonic processes of this domain. Bedding surface extensional openings and development of second order structures with N–S (E3) and NW–SE (E2) orientation controlled the tectonic genesis of the majority of orebodies and mineralised zones forming the Telfer ore system.

Key words: Telfer, Au-Cu system, tectogenesis, extensional model, convex structures, basement, Australia.

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INTRODUCTION

Telfer is a world class Au-Cu deposit, and as a gold resource it ranks within the top ten ore systems in the world (Fig. 1). It lies within the largely concealed Proterozoic Paterson Orogen of North Western Australia (Fig. 2). Despite more than 30 years of exploration and research, open-cut and underground production at Telfer since its discovery in 1972, it is obvious that a tremendous amount of potential remains and our understanding of the nature and controls on mineralisation is limited (Baker, 1994).

Since its discovery, several structural models of the deposit's ore system geometry have been developed. In general, two significantly different concepts for tectonic deformation and the mineralisation-controlling mechanisms have been proposed:

(1) A mechanism comprising regional horizontal compression, including strike-slip, fold flexural-slip, thrust, and inhomogeneous tectonic shortening of the host rock sequence for mineralisation emplacement, and

(2) A mechanism comprising a local (Telfer-scale) basement upward propagated shear-extensional tectonic deformation regime and corresponding mineralisation events.

In this paper the development of conceptual ideas on the Telfer tectogenetic model, in particular for the ore system, are discussed. Despite many years of intensive exploration and mining of the deposit, satisfactory evidence has not been found in support of regional compression as an adequate explanation of relationships between deformation geometry and distribution of mineralisation.

More recently, systematic tectogenetic analysis has been applied in the search of an alternative model to be used in the interpretation of ore system forming tectonic mechanisms (Bogacz, 2001, 2002b). Based on this approach, a new Telfer ore system tectonic genesis model has been developed, with a predictive capacity indicating potential positioning of the mineralised zones. Key aspects of this model are explained in the following paragraphs.

REGIONAL GEOLOGICAL BACKGROUND

Prior to reconnaissance mapping by the Geological Survey of Western Australia during 1974–1975 geological knowledge of the Paterson Orogen was extremely limited

Fig. 1. An aerial view of the Telfer deposit prior to commencement of production (middle 1970's). Looking North

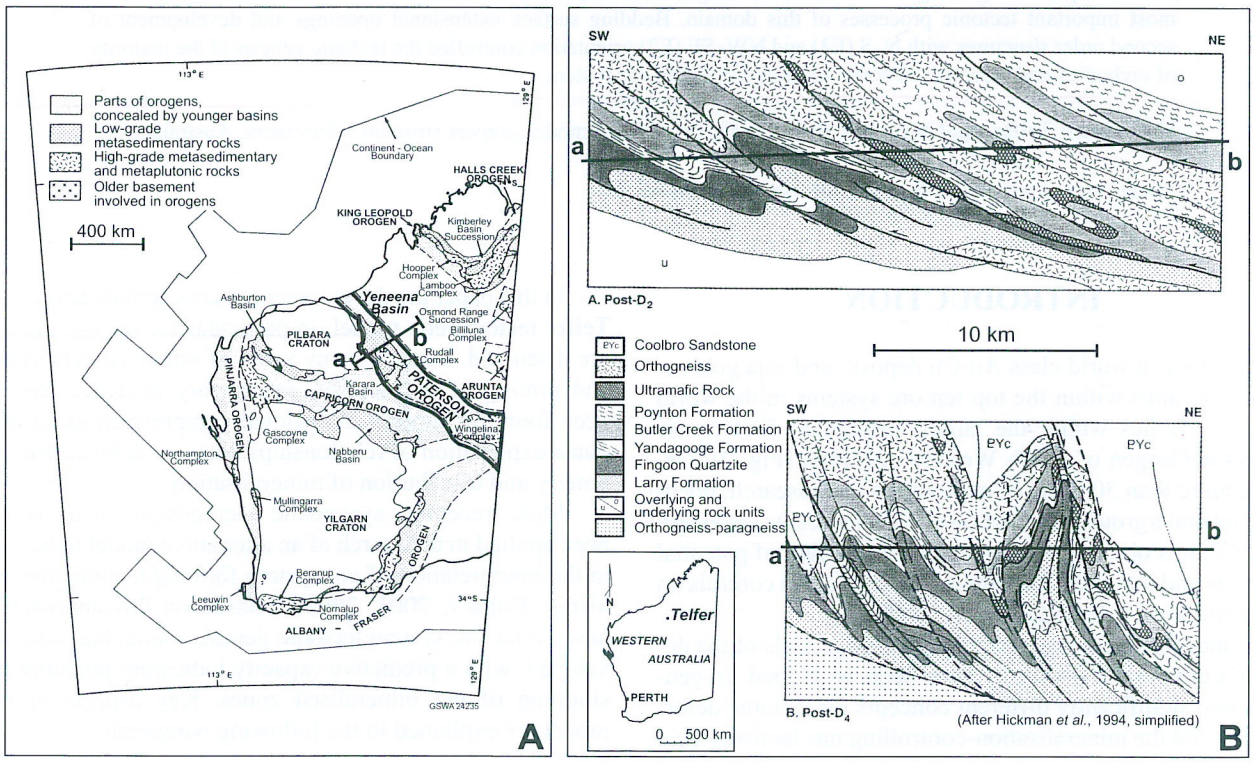

Fig. 2. Paterson Orogen: **A** – geological setting, **B** – thrust-style of tectonic deformation

(Hickman *et al.*, 1994). The mapping and investigation of regional geology and lithology (Blockley & de la Hunty, 1975; Hickman *et al.*, 1994; Bagas *et al.*, 1996), and tectonic evolution and structural setting (Ethridge *et al.*, 1987; Williams & Myers 1990; Hickman *et al.*, 1994 and, recently, Bagas, 2004) of the Paterson Orogen indicate the following.

Lithostratigraphy. The Paterson Orogen consists of the Ruddal Complex, predominantly igneous and sedimentary rocks metamorphosed to amphibolite facies, uncon-