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A Single Late Orogenic Permian Episode of Gold Mineralization in the Hodgkinson Province, North Queensland, Australia

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Abstract

Quartz-hosted gold deposits in the Hodgkinson province, north Queensland, are widely distributed with the most heavily endowed areas comprising three separate, spatially distant goldfields: the West Normanby goldfield, the Palmer River goldfield, and the Hodgkinson goldfield. Relationships among quartz vein- and shear-hosted deposits in each of the three goldfields indicate that the introduction of gold-bearing quartz displays consistent structural timing relative to a regionally recognized deformation history. Gold was emplaced during the waning stages of D_4, the main contractional phase of the Permian-Triassic Hunter-Bowen orogeny. Mineralization and structures have been structurally timed relative to isotopically dated plutons of the spatially associated syn-D_4 Whypalla supersuite, indicating emplacement of the mineralization in the Early Permian or later. Emplacement of gold-bearing quartz veins in the fossiliferous Permian Normanby Formation in the north of the province supports this contention. The Permian age is younger than the originally published Carboniferous (~300 Ma) age for gold mineralization in the Hodgkinson province. Fluid generation and gold transport were related to regional-scale devolatilization during province-wide metamorphism. The final distribution of fluids and contained gold was controlled by faults produced during the Hunter-Bowen orogeny and by major Late Devonian shear zones that were reactivated during this orogeny. Heat from synchronously emplaced D_4 granites focused enhanced fluid flow into spatially associated dilatant structures in these faults.

Introduction

Numerous hard-rock gold mines are hosted within multiply deformed Silurian-Devonian rocks of the Hodgkinson province, within the Tasman orogenic zone in north Queensland, Australia. Gold production dates from 1865 to 1885, but small-scale hard-rock mining is current in the West Normanby goldfield (Fig. 1). Although accurate production figures are unavailable, the extent of workings from the last century indicates that all three goldfields yielded significant resources. A recent review by Garrard (1997) recorded historical production of the Hodgkinson goldfield as 10 metric tons (t) Au. In the period 1994 to 1996, contemporaneous production from the West Normanby was some 27 kg. No production figures have been located for the Palmer River goldfield.

Previous workers in the Hodgkinson province have interpreted the gold-bearing vein systems as synchronous with compressional deformation associated with subduction-related tectonic processes (Davis and Hippertt, 1998; Bell, 1998). Groves et al. (1998) have suggested that the best term for such gold occurrences is orogenic gold deposits. Consequently, Hodgkinson gold-bearing quartz deposits have affinities to numerous other gold-rich terranes of both Phanerozoic and Archaean age (table 1, Groves et al., 1998).

Orogenic gold deposits typically show late orogenic emplacement linked to subduction-related thermal processes. The Hodgkinson province has been affected by two major orogenies, an unnamed one in the Late Devonian-Early Carboniferous and the Permian-Triassic Hunter-Bowen orogeny. Both orogenies produced north-south–trending faults and zones of intense foliation that are axial plane to folds of all scales. Structures produced in the Hunter-Bowen orogeny have commonly formed coplanar to preexisting ones, thereby producing large tracts of rocks characterized by composite cleavage and folds and reactivated earlier faults. Gold deposits are hosted in, or lie adjacent to, structures that developed during either or both of the two orogenies. The most significant of these deposits can be broadly grouped into three separate goldfields: the West Normanby in the northern sector of the province, the Palmer River in the northwest, and the Hodgkinson in the central southern portion (Fig. 1).

This is the first paper to incorporate both the ages of the deposits and their structural settings into a comprehensive province-wide tectonic mineralization model. Data from the West Normanby goldfield, the Palmer River goldfield, and the Hodgkinson goldfield have been integrated with the results from previous studies, in particular those from the South Palmer River region (e.g., Halfpenny and Hegarty, 1991; Davis, 1993, 1994; Davis and Forde, 1994; Forde and Davis, 1994) and the Rumula region to the south (Gregory, 1978; De Roo, 1988; Cranfield and Hegarty, 1989; Davis, 1997; Davis et al., 1998a).

Structures have been timed relative to isotopically dated igneous bodies (e.g., Bultitude and Champion, 1992; Davis and Henderson, unpub. data) and correlated with those of previous workers (Table 1). Spatial and/or temporal development of structures has been resolved from over 6,000 spatially oriented thin sections and by field documentation of overprinting relationships between deformation fabrics, metamorphic minerals, and fault systems. From this, we present overprinting and paragenetic relationships demonstrating that the emplacement of gold was the result of a single widespread tec-

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