A Mesoproterozoic palaeomagnetic age for the gold-bearing Quamby Conglomerate, Queensland

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The Quamby gold deposit in the Eastern Fold Belt of the Mount Isa Inlier is hosted by the Quamby Conglomerate. This fold belt also contains several Cu–Au deposits, including the major Ernest Henry deposit ~40 km east of Quamby, which are believed to have been formed by hydrothermal processes related to the intrusion of the nearby ~1500-Ma Williams and Naraku batholiths. The genetic link between the Quamby deposit and the others is not clear, partly because the age of the conglomerate has remained uncertain. We describe here the results of palaeomagnetic dating of the conglomerate, which was carried out to help understand the origin of the Quamby deposit and gold mineralisation in the Eastern Fold Belt in general.

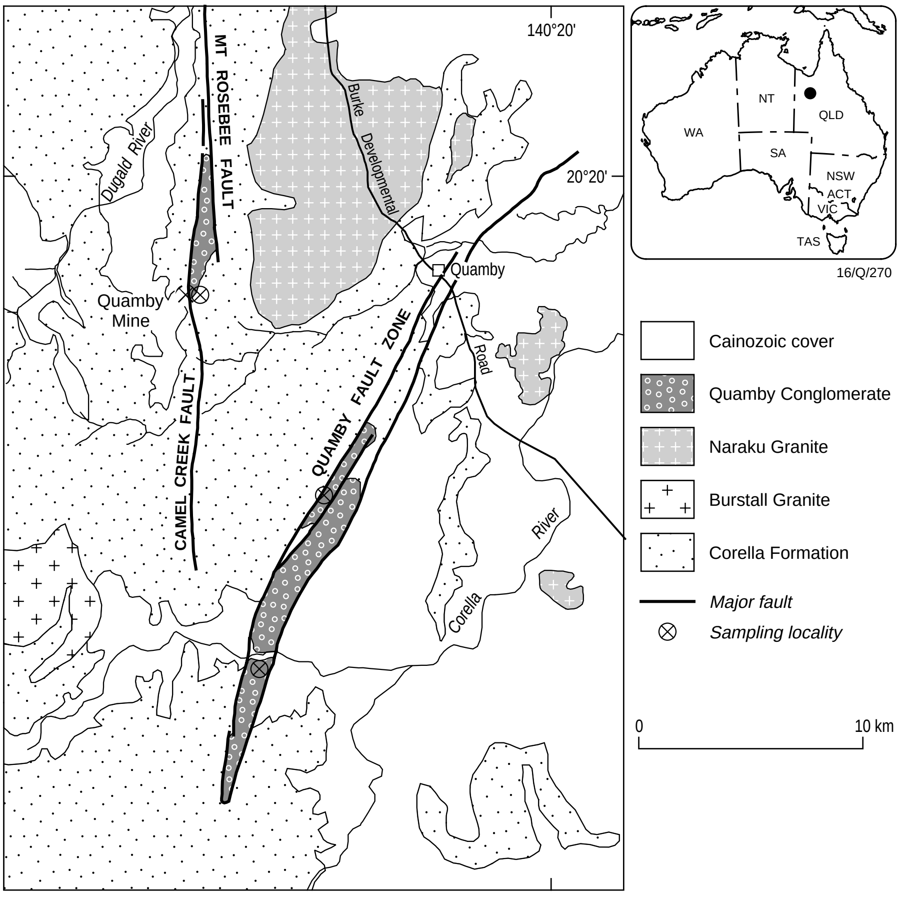

Fig. 5. Simplified geological setting of the Quamby Conglomerate, and sampling localities.

The Quamby Conglomerate comprises mainly conglomerate, feldspathic sandstone, and greywacke. Clasts include slate, schist, and quartzite. Hematite is ubiquitous, and is regarded as postdepositional, possibly of hydrothermal origin. The unit crops out in two northerly and north-northeasterly trending graben-like structures (Fig. 5), where it is unconformably underlain by metasediments mapped as the Palaeoproterozoic Corella Formation. The northern block, which contains the deposit, is bounded by the Mount Rosebee and Camel Creek Faults; the southern block lies within the Quamby Fault Zone. Although tightly folded at some localities, the unit contains no evidence of metamorphism; its maximum age, therefore, is ~1550–1500 Ma — the end of the last period of regional metamorphism in the Mount Isa Inlier. The Late Proterozoic and Phanerozoic previously have been tentatively suggested for its age (e.g., Connor et al. 1990, in F.E. Hughes, Editor: Mineral deposits of Australia and Papua New Guinea, Australasian Institute of Mining & Metallurgy, Melbourne, 949–953; Derrick 1980: Marraba, Queensland, 1:100 000 Geological Map Commentary, BMR/AGSO).

Palaeomagnetic techniques

We collected 110 oriented samples from red arenite lenses and the least pebbly beds at twelve spot localities in the northern and southern blocks. Forty-nine other samples were obtained from cobbles of slate within the conglomerate, to check that their remanences have random directions (i.e., are not postdepositional overprints). Standard thermal demagnetisation techniques, comprising normally 26 heating steps in the range 100–695°C, were used for analysing the components of remanence.

The magnetisation intensity of the typical arenite sample changed little up to at least 600°C, and with few exceptions the arenite remanences contained a single component. Figure 6A shows the site mean directions for that component together with the 95% confidence circles. Corrections for bedding dips halved the directional scatter, indicating that the magnetisation was acquired before deformation. Eleven of the twelve site mean directions form a pair of antipolar groups that represent either identical or closely similar ages. The twelfth direction (marked X in Fig. 6A) cannot be assigned to either group, and does not correspond to any part of the Australian apparent polar-wander path (APWP). (The cause of the discrepancy is not clear; it may be due, for example, to unrecognised structural complexity at the site.) Discarding the discrepant direction and assigning equal weights to the eleven concordant directions produces an overall mean direction of declination 3.9° and inclination –31.2° (α_{95} = 5.5°). This equates to a palaeomagnetic pole at latitude 85.0°S and longitude 7.4°E (A_{95} = 5.4°), labelled QC on the APWP (Fig. 7).

Although the remanences of the slate cobbles are poorly defined, most reveal two components. The first demagnetised in the hematite temperature range well above the Curie point of magnetite (580°C), and yielded random directions, as expected for the magnetisation of cobbles deposited in random orientations. The second component unblocked below the Curie point of magnetite. Its directions, although highly scattered, are not random (Fig. 6B). Part of the scatter may be due to the presence of the higher-temperature random component, which may not have been completely eliminated by demagnetisation. The mean field-corrected direction for this component is declination 307.8°, inclination 39.6° (α_{95} = 22.9°), equating to a pole (QCC in Fig. 7) at latitude 21.4°S and longitude 269.2°E (A_{95} = 22.9°). In view of the poor quality of the results and the large scatter among sample directions, this pole should be regarded as only a rough approximation.

Age of the Quamby Conglomerate

The pole QC for the Quamby Conglomerate plots on the Australian APWP near but on the younger side of the pole IM, which represents the final stages of metamorphism in the Mount Isa Inlier. This is consistent with sedimentation of the Quamby Conglomerate postdating regional metamorphism. The closeness of the two poles suggests that the hematite was introduced soon after the metamorphism. Therefore, the age of the unit is inferred to be ca 1500 Ma, which leaves open two interpretations for the origin of the gold.

Firstly, this age corresponds to the period of widespread circulation of hydrothermal fluids that probably produced the Cu–Au deposits in the Eastern Fold Belt (Perkins & Wyborn 1996: AGSO Research Newsletter, 25, 8–9). In view of the proximity of the Mount Rosebee and Camel Creek Faults, these fluids may account for both the gold and secondary hematite in the unit. We note a similar association of gold with chemically deposited hematite at Ernest Henry (Craske 1995: Australian Institute of Geoscientists [AIG], Bulletin, 16, 95–109).

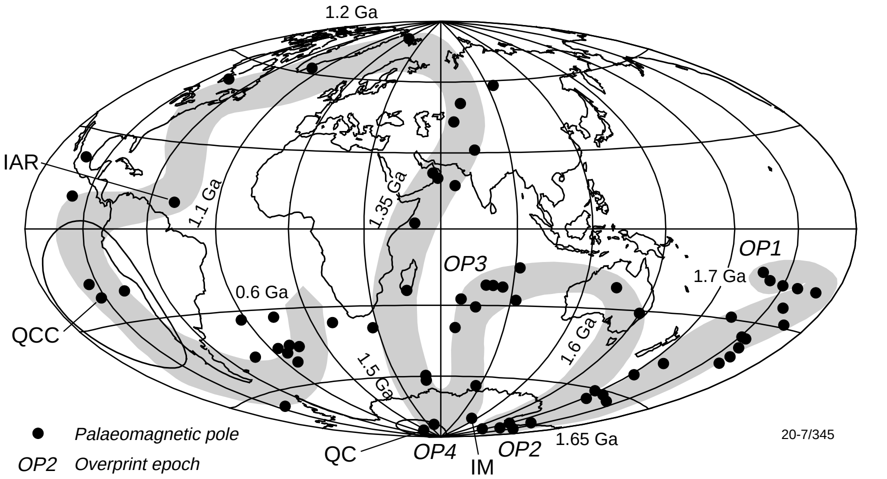

Fig. 7. 1700–600-Ma APWP for Australia (Idnurm et al. 1995: Precambrian Research, 72, 1–41) showing the pole QC for the Quamby Conglomerate in relation to the pole IM, which represents the last period of metamorphism in the Mount Isa Inlier. Also shown is the pole QCC from individual cobbles, which appears to represent a Grenvillean overprint, and the pole IAR from the Lakeview Dolerite and other coeval postmetamorphic dykes of the Mount Isa Inlier.

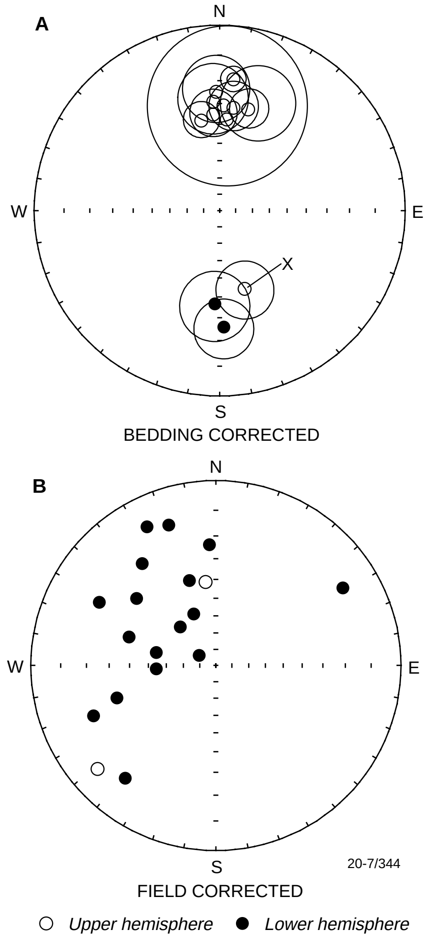

Fig. 6. Remanence directions of the Quamby Conglomerate: (A) Site mean directions and their 95% confidence circles in the arenites; the anomalous site mean direction is labelled X. (B) Overprint directions in the cobbles.

Secondly, the gold may be detrital, having been eroded from older rocks uplifted at ~1500 Ma and deposited on the beds of streams that followed the active faults. Recent petrological evidence seems to favour a detrital origin (Register of Australian Mining 1997/1998, Resource Information Unit, Subiaco, p. 194), but does not rule out a hydrothermal contribution.

A Grenvillean thermal event at Mount Isa?

The remanence component with the lower unblocking temperature in the slate cobbles appears to be a partial overprint superposed on either a primary magnetisation of the cobbles or some predepositional secondary magnetisation. Its absence from the arenite samples may be due to the high magnetic stability of the hematite in the arenite to heating. What caused the overprinting?

The pole QCC for the cobbles lies roughly on the same part of the APWP as the pole IAR for the postmetamorphic dykes of the Mount Isa Inlier (Fig. 7). These dykes include the 1100-Ma Lakeview Dolerite, which has been traced to within 35 km of the southernmost sampling site. The pole could thus represent either a thermal or a chemical overprint associated with the 1100-Ma magmatism. The Mount Rosebee and Camel Creek Faults could have channelled heat or fluids to the Quamby Conglomerate. Temperature estimates based on theoretical calculations for pure magnetite (Middleton & Schmidt 1982: Journal of Geophysical Research, 87, 5351–5359), and a conservative unblocking temperature of ~500°C, suggest that a thermal overprint would have required a minimum temperature of 250°C for heating durations of 10 m.y. or less. Alternatively, secondary magnetite deposited from fluids that circulated at the time of the intrusion could be the source of a chemical overprint.

The magmatism may be part of the Grenvillean orogenesis, for which evidence has been sought in northeastern Australia.

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