Review by Kevin Hill of

The location of lithospheric-scale transfer faults and their control on the Cu-Au deposits of New Guinea

By L.T. White, M.P. Morse and G.S. Lister

The authors aim, stated in the discussion on section 4.2 on page 1699, was “to present a methodical and systematic method of mapping lineaments in a way that the reader could clearly evaluate our work and come to their own judgement as to whether arc-normal faults exist in New Guinea”. This is an excellent goal, particularly to test previous hypotheses concerning inferred ~NE-trending lineaments continuing from northern Australia to the New Guinea margin. In terms of remote sensing data and to some extent topographic data, they have achieved this goal with a comprehensive analysis of published data over the northern Australia and New Guinea region. The paper makes a significant contribution to our knowledge by analysing and assessing gravity, magnetic, tomographic and to a lesser extent topographic data to determine likely lineaments and patterns of basement fabric in Northern Australia continuing into New Guinea. They presented a clear methodology for interpreting those datasets and developed a new geophysics-based lineament map for the area that is quite different to previous models. Their new lineament map shows dominantly arc-parallel lineaments in the New Guinea orogenic belt and a northerly trending fabric on the undeformed foreland (the Australian margin) to the south in New Guinea and northern Australia. Only a handful of NE-trending lineaments were identified in the orogenic belt, based largely on gravity and tomographic data, as shown on their figure 10.

The authors were able to use this new map to test the existence of a previously inferred NE-trending fabric in basement and its potential reactivation to allow the ascent of magma and mineralising fluids to create world-class ore bodies. This theory had been developed on the basis of major ore bodies lying along such NE-trending lineaments across the fold belt in New Guinea. They concluded that there was some evidence for NE-trending lineaments from the gravity and tomographic data, but that an array of different lineaments was prevalent in southern New Guinea and northern Australia such that there was no through-going NE fabric. On page 1700, they proposed four different theories for the difference between the previous models and their new model, but declined to state which theory they preferred. They did, however, note that their NE-trending lineaments only coincide with ore bodies younger than 4.5 Ma and propose that there may be a genetic link, but that older bodies, such as the giant Porgera and Mount Kare deposits in PNG, require a different genetic model. Analysing a World-Bank-funded aeromagnetic dataset over the PNG fold belt they concluded that the Porgera-Mount Kare lineament is not a magnetic feature or does not exist. Similarly, analysing the best available topographic data, they did not identify any regional NE to N striking lineaments in northern Australia, the Arafura Sea or in New Guinea (page 1695).

In terms of methodology, the authors have obtained the best public datasets and clearly stated how they were analysed. The significant omission in the study is the lack of consideration of geology and the relation of their work back to geologic maps. Of all the regional NE-trending lineaments in the PNG fold belt, the Porgera-Mount Kare lineament is the most obvious from geologic maps and

structural analysis (Corbett 1994, Hill et al 2002, Hill 1991). As Hill et al (2002) stated, from south to north, the regional lineament is defined by the SE limit of the 120 km long basement-cored Muller Anticline, the NW limit of the low-lying (~1800m) and volcanic -filled Tari Basin, the NW limit of deformed basinal Mio-Pliocene strata in the high (~3000m) Andabare Plateau, the SE limit of the 120 km long, low-medium grade Om metamorphic terrane, the NE limit of the Miocene Maramuni igneous province and a 50 km offset NE-SW offset of the ophiolite belt. Given that these geologic provinces are typically 50-200 km long it is likely that the belt across which they terminate is of a similar dimension and hence lithospheric in nature. Perhaps the question for the authors should be why did their analysis not detect one of the most significant geologic lineaments across the New Guinea orogenic belt, particularly the one along which some of the world's biggest ore bodies were emplaced.

Regarding referencing, it is misleading to state that Hill (1991) proposed arc-normal transfers across New Guinea, which is 2000 km long. The paper focussed on the structural geology of the 300 km long and 100 km wide Papuan Fold Belt from a hydrocarbon perspective, with no mention of Cu-Au deposits, which were never considered. Hill proposed four ~NNE-trending lateral ramps across the fold belt that separated areas with fundamentally different structural styles, detachment depths, thermal maturities for hydrocarbons and terranes of different elevation. Please note that there has been some further support for these ~NNE-trending tear faults in the Papuan Fold Belt from surface geology, seismic and aeromagnetic data, eg Hill et al 2008 and 2010. Furthermore, on page 1700 lines 10-20, the authors misunderstood the relationship between the NE-trending 'transfer' faults across the orogen and the NW-trending faults parallel to the orogeny. Hill (1991) suggested that both fault orientations developed during extension in the Mesozoic as down-to-the-basin faults offset by transfer faults. Such a fault system is currently observed in the Timor Sea and along Australia's NW Shelf (eg Longley et al 2002 and Hill et al 2010). Both fault sets were considered to have been reactivated in the Late Miocene to Pliocene and controlled the development of anticlines in the Papuan Fold Belt.

In summary, it is excellent to test the existence of lineaments objectively using geophysical data, using different sun-angles and combinations of data. It is likely that further analysis of topography and drainage patterns is warranted rather than focussing on the 10, 100 and 1000m contours. Most importantly, the study should be related back to the regional geology.

Comments and Minor errors/typos in the paper

Abstract – line 6-7: previous work was not presented or of low resolution – it is hoped that the diagrams in *this* paper will be available at a much bigger scale than currently presented. Few of the features discussed are visible on the figures shown which range from 1-10 cm across, for instance the Bosavi lineament in Figure 2.

Abstract, first line should be 'locations' with an s as plural is used.

Abstract - Not all deposits are Cu-Au

Abstract 5th line poorly worded, the fluids and gas are not deposited.

Abstract, line 6 ’data’ is used as singular; line 10 data used as plural, line 15 data used as plural, Section 2 line 5 data used as plural but on line 6 used as singular, page 1692 line 2 data singular. The word ‘data’ should be used consistently throughout the paper. Data are plural and datum is singular.

Abstract line 9 parentheses unnecessary and ugly in abstract.

Introduction

Line 25. Bosavi lineament was proposed by oil industry and recorded by Smith (1990).

Line 25-26. “data not presented or resolution is too low” exactly the same error occurs in this paper where the figures are so small no details can be discerned.

Page 1692 line 28, the Fugro study was sponsored by the World Bank and is publically available.

Page 1693 line 15 remove ‘the’

Page 1702 line 2 course should be coarse.

Longley, I. M., Buessenschuett, C. et al. 2002. The North West Shelf of Australia – a Woodside perspective. In: Keep, M. & Moss, S. J. (eds) The Sedimentary Basins of Western Australia 3. Proceedings of the Petroleum Exploration Society of Australia Symposium, Perth, WA, 27–88.

Hill, K. C., Bradey, K., Iwanec, J., Wilson, N. & Lucas, K. 2008. Structural exploration in the Papua New Guinea Fold Belt. In: Blevin, J. E., Bradshaw, B. E. & Uruski, C. (eds) Eastern Australasian Basins Symposium III. Petroleum Exploration Society of Australia, Special Publication, 225–238.

Kevin C. Hill, Katie Lucas and Keith Bradey; *Geological Society, London, Special Publications* 2010; v. 348; p. 33-56. Structural styles in the Papuan Fold Belt, Papua New Guinea: constraints from analogue modelling.