Recognition, structural significance, and prospectivity of early (F_1) folds in the Minerie 1:100 000 Sheet area, Eastern Goldfields, Western Australia

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In the Eastern Goldfields, shear zones and folds near major faults have controlled gold mineralisation, so an understanding of their configuration is essential in the search for ore. It is also needed to resolve the adjacent stratigraphy, geological evolution, and prospectivity. This report documents the recognition of large F_1 folds extending over 1000 km² in the southern part of the Minerie Sheet area. D_1 faults associated with one of the folds may be prospective for gold, as in the neighbouring Leonora area.

Regional geology

The Minerie region is located in Western Australia's Yilgarn Craton (Fig. 3), and was mapped by AGSO from 1989 to 1995 as part of the National Geoscience Mapping Accord. It comprises a sequence of Archaean greenstones — metamorphosed felsic volcanic and volcaniclastic rocks, mafic flows and sills, ultramafic rock, and minor sedimentary rocks — intruded by granite*, rare syenite, and Proterozoic mafic dykes.

Structure

In the southern part of the Minerie Sheet area, major folds (F1 and F2) and foliation trends (S1 and S2; Fig. 4) are products of D_1 and D_2 deformation. Two key areas are critical to the interpretation.

Firstly, in the east, a large north-northeast to northeast-trending open to close upright syncline is cut at right-angles in its hinge zone and west limb by a steep northwest-striking foliation. The foliation is assigned to S_2 because it is a prominent schistosity that parallels the general direction of S_2 foliation throughout the Eastern Goldfields. Hence, the syncline is F_1. A steep north-northeast-striking foliation, also in the hinge zone of the syncline, parallels the fold's axial plane, and is assigned to S_1. The recognition of this upright F_1 fold raises the possibility of others being present, and three north-northeast-trending open folds in the south may be such.

Secondly, the outcrop pattern of the volcaniclastic conglomerate, sandstone, and tuff of the Welcome Well Complex and its lateral felsic volcanic equivalents to the west is strongly suggestive of an isoclinal F_1 fold subsequently folded by the F_2 Benalla Anticline. The strata face north on the northern limb and south on the southern limb. The F_1 fold is therefore a tight to isoclinal anticline, possibly originally recumbent. Its limbs form a south-plunging arc, and its hinge zone has been disrupted and stoped by dolerite. Hence, the original attitudes of the F_1 axis and axial plane are indeterminable. Symmetrically unfolding the Benalla Anticline about its north–south axial plane causes the F_1 fold to take up an east–west trend; Figure 5 shows a

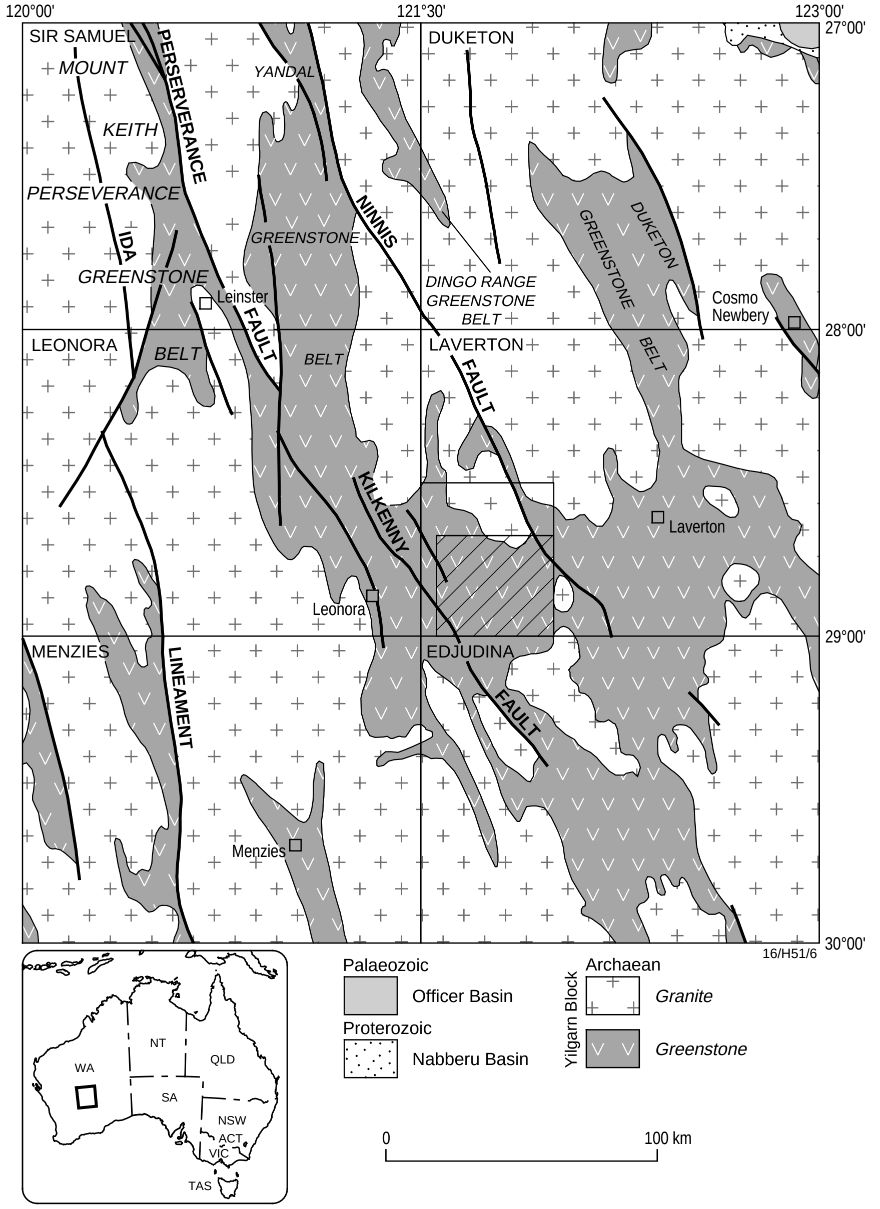

Fig. 3. Regional geology of the central Eastern Goldfields province (after Myers & Hocking, compilers, 1988: Geological map of Western Australia, 1:2 500 000; Geological Survey of Western Australia). The rectangle represents the location of the Minerie 1:100 000 Sheet area; the hachured area, Figure 4.

* 'Granite' includes syenogranite, monzogranite, granodiorite, and tonalite.

possible sequence of events that led to the present outcrop pattern.

A third foliation, mapped in the country rocks next to the granite body in the north, parallels the granite margin, and may have formed by shear with or without flattening during forceful emplacement.

Discussion

The north-northeast to northeast trend of the eastern F_1 fold is unusual for the Eastern Goldfields. Large D_1 structures generally trend easterly where they are not reoriented by D_2 (Archibald et al. 1978: Precambrian Research, 6, 103–131), or are parallel to D_2 structures where they have been reoriented (Swager & Griffin 1990: Precambrian Research, 48, 63–73; other references in Swager 1997: Precambrian Research, 83, 18). Witt (1994: Geological Survey of Western Australia, Melita 1:100 000 Explanatory Notes) recognised north-, east-, and northeast-trending large F_1 folds reoriented by D_3 in the northeast of the Melita Sheet area, immediately southwest of Minerie. S. Liu (AGSO, personal communication August 1998) suggests that sinistral movement along the Kilkenny Fault (Fig. 4) could have rotated originally east–west F_1 folds to their present north-northeast to northeast trend during D_2 and perhaps D_3.

Chen et al. (1998: Geological Society of Australia, Abstracts 49, 79; in press: Geological Survey of Western Australia, Annual Review 1997–98) and Liu & Chen (1998: ibid., 278) accounted for the north-northeast-trending folds (F_1 of this report) by local compression during east–west D_3 transpression. The folds formed within antidilational jogs defined by sinistral strike-slip on north-northwest-striking faults. The northwest-striking S_2 foliation that cuts the eastern F_1 fold (Fig. 4) contradicts their interpretation.

Two layer-parallel faults on the western limb of the folded F_1 anticline in the west may be D_1 faults. The folded backthrust cutting the core of this fold (Fig. 5) is also D_1. D_1 shears in the Leonora area carry gold (Williams et al. 1989: Australian Journal of Earth Sciences, 36, 383–403; Williams 1998: AGSO Record 1998/9), and so the interpreted D_1 faults in the Minerie area may be similarly prospective. Several small gold mines are located on or near the eastern layer-parallel fault.

Fieldwork planned in connection with second-edition compilations of the Leonora and Laverton 1:250 000 geological maps will include examination of the various foliations in the Minerie region, their nature and relationships to folds, and shear near the granite contact.

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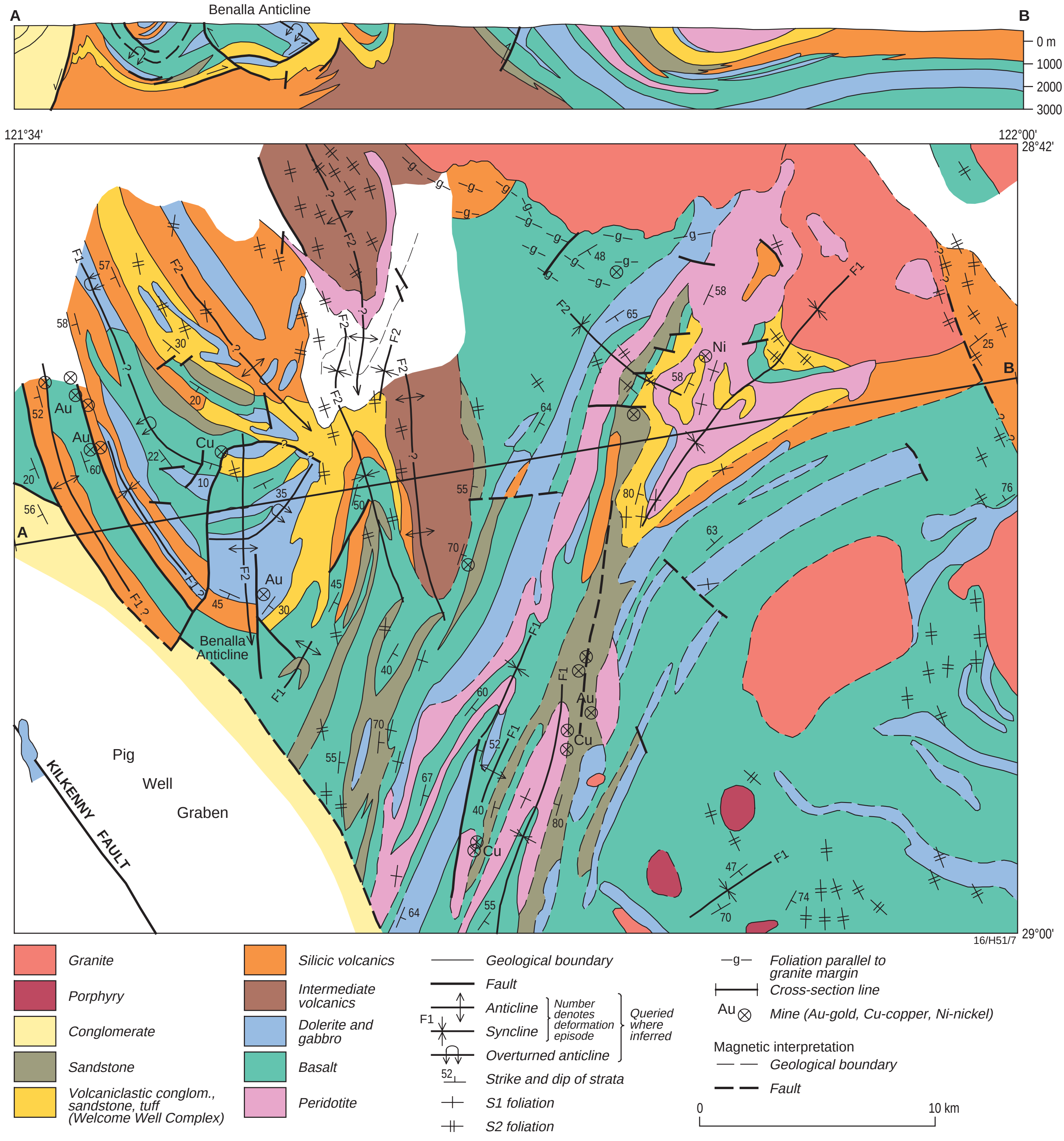
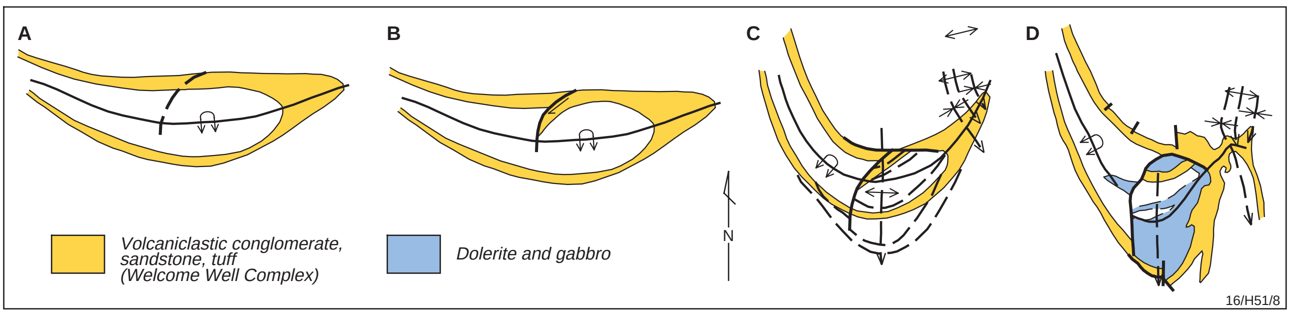
FIGURES 4 & 5 on opposite page.

Fig. 4. Solid-geology map and cross-section (from mapping by P.R.Williams, M.B.Duggan, and K.L.Currie, 1989–91, and interpretation of aeromagnetic data by the author) of the southern Minerie 1:100 000 Sheet area.

Fig. 5. Possible sequence of events that led to the present outcrop pattern of the Welcome Well Complex and laterally equivalent felsic volcanic units. (a) Isoclinal F_1 anticline. (b) Backthrust in lower limb. (c) Flexure around F_2 Benalla Anticline; dashed lines show subsequent position of strata after dolerite intrusion (which is just as likely to have occurred after stage b and before stage c). (d) F_2 folding of the hinge of the F_1 fold, and intrusion of dolerite.


A
Benalla Anticline
B
0 m
1000
2000
3000
121°34'
122°00'
28°42'
29°00'
Pig
Well
Graben
KILKENNY FAULT
Benalla Anticline
Au
Cu
Ni
16/H51/7
Granite
Porphyry
Conglomerate
Sandstone
Volcaniclastic conglom., sandstone, tuff (Welcome Well Complex)
Silicic volcanics
Intermediate volcanics
Dolerite and gabbro
Basalt
Peridotite
Geological boundary
Fault
Anticline
Syncline
Overturned anticline
Number denotes deformation episode
Queried where inferred
Strike and dip of strata
S1 foliation
S2 foliation
Foliation parallel to granite margin
Cross-section line
Mine (Au-gold, Cu-copper, Ni-nickel)
Magnetic interpretation
Geological boundary
Fault
0
10 km


A
B
C
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Volcaniclastic conglomerate, sandstone, tuff (Welcome Well Complex)
Dolerite and gabbro
16/H51/8