



**SURFACE AND UNDERGROUND GEOLOGICAL STRUCTURES
AT THE CAROLIN GOLD MINE
(92H/11)**

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INTRODUCTION

The Carolin mine gold deposit is situated about 20 kilometres northeast of Hope. The complex, replacement-type mineralization is hosted in Jurassic metasedimentary rocks of the Ladner Group, close to both their unconformable contact with Early Triassic (?) volcanic greenstones and their faulted contact with ultramafic rocks of the Coquihalla serpentine belt (Fig. 39). The mine started regular production in 1982; ore reserves at that time were reported to be 1.5 million tonnes averaging 4.8 grams gold per tonne, at a cutoff grade of 2.7 grams gold per tonne.

The sulphide-albite-quartz-gold mineralization is both lithologically and structurally controlled within the hinge regions of large scale antiformal folds (Shearer and Niels, 1983). Both the major and minor geological structures mapped on surface at Carolin mine (Figs. 39 and 40) can be correlated with these subsurface, ore-controlling folds. This report presents an analysis of the surface structural data which can be used to predict the orientation and geometry of the ore-related folds.

GEOLOGICAL STRUCTURE AT CAROLIN MINE

The structural history of the mine area is shown in Table 1. The first deformational episode resulted in tectonic inversion of both the Ladner Group and the older greenstone sequence, although no related folds or structural planar fabrics from this episode have been recognized. The second deformational event (D2) produced the dominant fold pattern in the mine area (Table 1). This formed upright, concentric to overturned and asymmetric minor and major folds; the major structures have wavelengths of 60 to 110 metres and amplitudes between 25 and 50 metres (Fig. 40; Ray, 1982). The D2 event was associated with the imposition of a weak to intense axial planar slaty cleavage in the siltstones and argillites, together with a well-marked bedding-cleavage intersection lineation orientated subparallel to the fold axes. This cleavage and mineral lineation is generally absent in the coarse-grained wacke units.

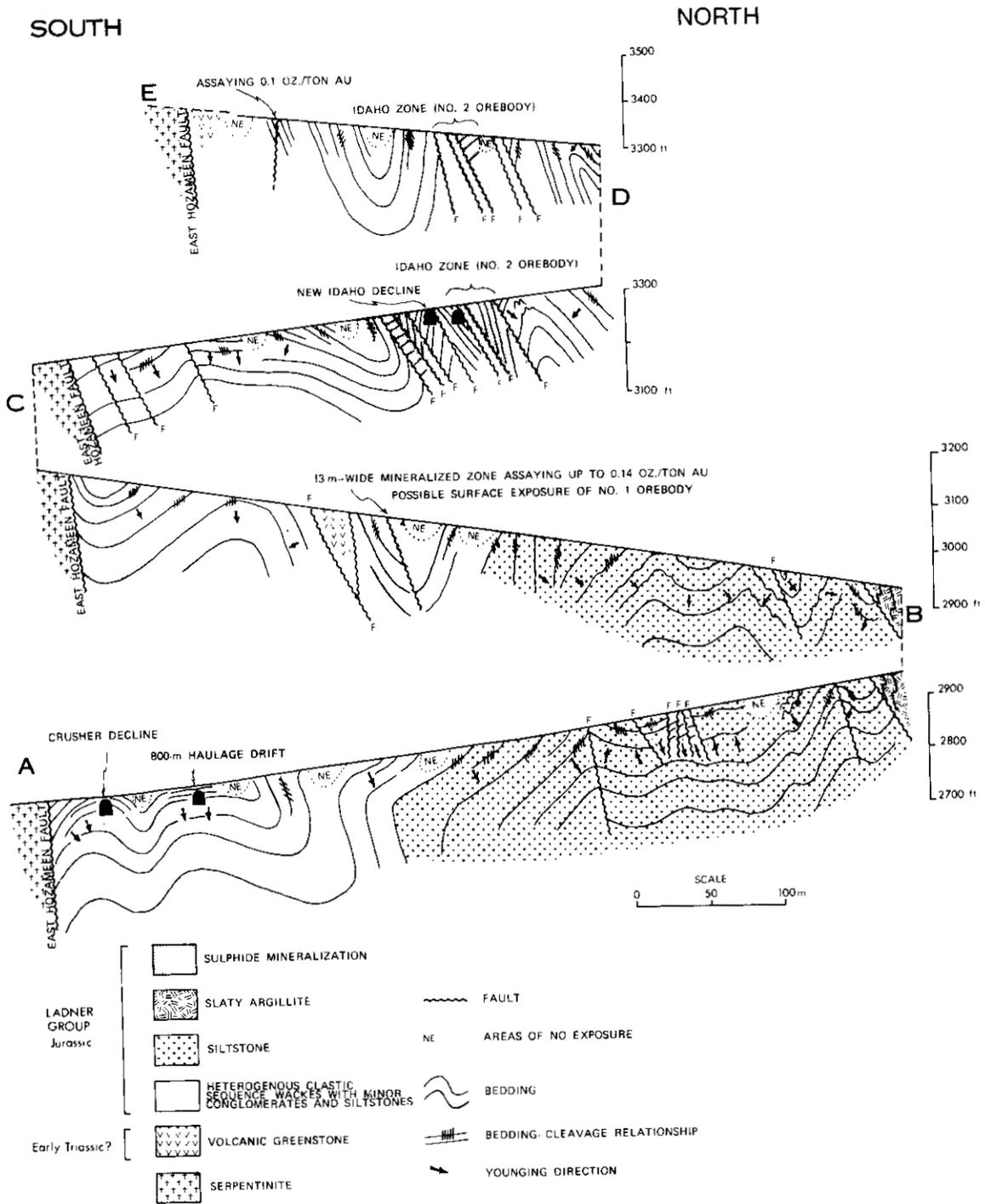


Figure 40. Geological sections across the Carolin mine area.

TABLE 1
HISTORY OF EVENTS IN CAROLIN MINE AREA

Age	Event
	Late faulting - southeast-trending set followed by a northeast to east-northeasterly striking set.
	Large scale dextral strike-slip movement along the Hozameen fault.
39 Ma	Intrusion of the Needle Peak pluton and related felsic dyke swarm.
Middle to Late Cretaceous	D3 - Asymmetric folding. Local kink folding and strain slip cleavage development.
Middle to Late Cretaceous	D2 - Major concentric to similar-type, open to tight asymmetric folding with southeast-striking axial planes and gently inclined, northwest-plunging axes. Development of regional slaty cleavage and mineral lineation.
Middle to Late Cretaceous	D1 - Easterly directed thrusting along the Hozameen fault causing local structural inversion of the Ladner Group and older volcanic greenstones.
Early Jurassic to Early Cretaceous	Deposition of the Ladner Group and other younger sedimentary rocks of the Pasayten trough.
	UUUUUU Unconformity
Early Triassic (?)	Greenstone volcanic eruption.

The geological cross-sections on Figure 40, together with a stereoplot of poles to bedding (Fig. 42A), show that most of the D2 structures in the mine area are open to tight, concentric, upright folds. These have southeasterly striking axial planes that dip steeply northeast at an average of 75 degrees (Fig. 42B). Lineation plots (Fig. 42C) reveal that the D2 fold axes have an average plunge of 12 degrees in a northwesterly direction; this is essentially similar to the estimated 20-degree northwesterly plunge of both the Carolin mine orebody and the axes of its controlling antiformal structures (Shearer and Niels, 1983).

While most D2 folds in the mine area are concentric and upright (Fig. 42A), there is the local development of tighter, asymmetric, similar-style folds that are overturned to the southwest (Fig. 40). Many of these small scale, overturned structures have disrupted, faulted hinge zones along which quartz veins are locally injected (Fig. 41); an identical pattern of fold hinge disruption is recognized in the large scale, ore-controlling, overturned folds mapped underground (Shearer and Niels, 1983). Figures 42D and 42E show that both the late faulting and quartz veining in the mine area are controlled strongly by the D2 slaty cleavage, and not by the bedding.

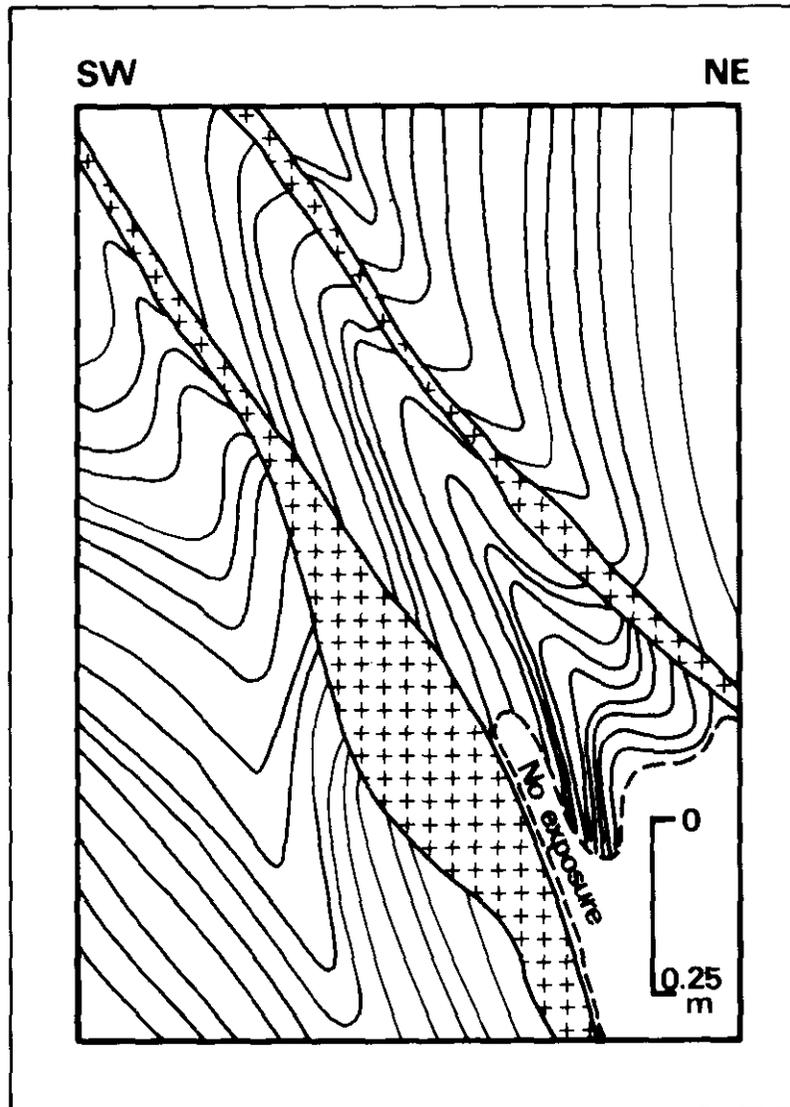


Figure 41. D2 similar-type folds in Ladner Group bedded siltstones. Note quartz veins (cross pattern) and disrupted hinge zones. (Taken from photograph of road outcrop, 290 metres east-northeast of old Idaho adit, Carolin mine).

CONCLUSIONS

The dominant (D2) fold episode deforming the Ladner Group in the Carolin mine area produced mostly upright, concentric, open to tight structures. Locally, however, tighter, asymmetric, similar-style D2 folds were developed; these are overturned to the southwest and often have disrupted, faulted hinge zones.

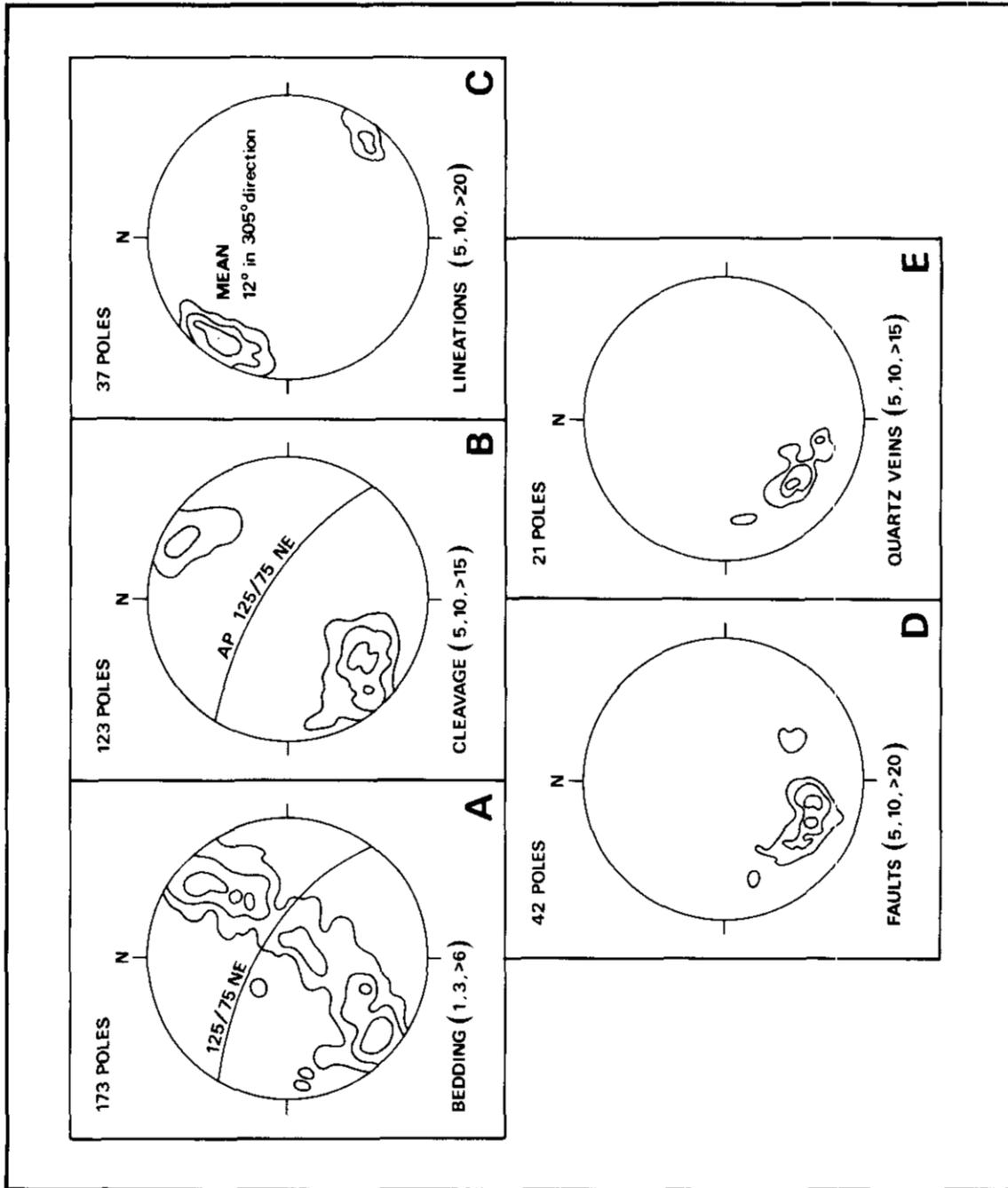


Figure 42. Ladhner Group - Carolin mine (surface). Lower hemisphere equal area projection. A - poles to bedding; B - poles to slaty cleavage; C - mineral lineations; D - faults; E - quartz veins. Numbers in brackets are contour intervals in per cent.

The mineralization at Carolin mine is largely confined to favourable lithological horizons within the hinge portions of large scale D2 antiformal folds (Shearer and Niels, 1983). These ore-controlling structures are identical in style to the overturned, asymmetric folds with disrupted hinge zones seen on surface at Carolin mine (Fig. 41). They have axes that plunge gently northwest and southeasterly striking axial planes that dip steeply northeast.

The temporal relationship between the gold mineralization and the D2 folding is unknown, although some of the associated quartz veins in the deposit have followed the slaty cleavage; this suggests mineralization either accompanied or succeeded the D2 structural episode. The orientation of the later faulting, which displaces the ore zones (Shearer and Niels, 1983), has also been largely controlled by the axial planar slaty cleavage rather than the sedimentary bedding; this fracturing is concentrated preferentially in the fold hinge areas.

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REFERENCES

- Ray, G. E. (1982): Carolin Mine-Coquihalla Gold Belt Project, B.C. Ministry of Energy, Mines & Pet. Res., Geological Fieldwork, 1981, Paper 1982-1, pp. 87-101.
- Shearer, J. T. and Niels, R.J.E. (1983): Carolin Mines: A geological Update, *Western Miner*, November 1983, pp. 21-24.