Geol. Mag. **122** (3), *1985, pp. 249–251. Printed in Great Britain*

The facing of faults

RICHARD J. LISLE

Department of Geology, University College, Swansea SA2 8PP, U.K.

(*Received* 2 November 1984; *accepted* 5 November 1984)

Abstract – It is proposed that the usage of the term *structural facing* be extended to include fault structures. Fault facing is defined as the direction in a fault plane which is at right angles to the trace of the bedding and is directed towards the younger beds. Certain types of faulted structures are found to have diagnostic patterns of facing variation.

1. Introduction

Facing or *structural facing* are terms used to describe the relationship between the orientation of a structure and the younging direction of the rocks affected by that structure. The term was first used in this sense by Cummins & Shackleton (1955) who applied it to structures in the Dalradian sediments of the Southwest Highlands of Scotland. Subsequent applications of the concept (e.g. Shackleton, 1958; Harris, 1962; Borradaile, 1976; Laing, 1977; Wood, 1978; De Wit, 1982; Boyer & Elliott, 1982) have shown facing to be a directional property of structures which is useful for the unravelling of the complex geometry of refolded areas.

The existing definition of structural facing concerns only folds. Folds are said to face in the direction of the stratigraphically younger beds along their axial surfaces and normal to their axes (Shackleton, 1958, p. 363).

With the upsurge of interest in the detailed geometry of fault systems in recent years there has been an increasing need to expand the vocabulary relevant to faulting. An important characteristic of a fault is its angular relationship to the stratigraphy it displaces and aspects of this relationship form the basis of fault classification (cf. Dahlstrom, 1970; Coward, 1982).

This note suggests that discussion of fault geometry would be made simpler if the facing concept is extended to include faults.

2. The facing of a fault

The following definition of fault facing is proposed: *A fault faces in the direction in the fault plane which is at right angles to the trace of the bedding and towards the younger beds.* As with fold facing, the direction is polar as opposed to axial so that *upward-facing* and *downward-facing* are distinct. Facing corresponds to the direction in which a fault cuts up section stratigraphically (Fig. 1).

A planar fault cutting previously unfolded sediments will possess more or less constant facing over the whole fault plane surface. Non-planar faults will have variable facing. Thrusts with a staircase geometry, for instance, will show an alternation of upward-facing parts (ramps) and neutral-facing parts (flats).

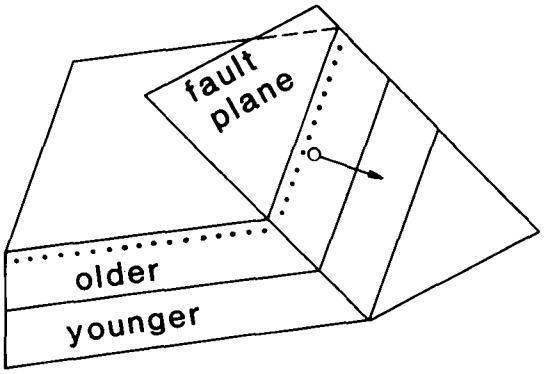

Figure 1. The definition of fault facing. The fault faces in the direction shown by the arrow. The direction corresponds to that in which the fault cuts up section in a stratigraphic sense.

3. Examples of structural deductions from fault facing

The manner by which facing varies along a fault provides evidence of the mode of origin of the structure. Facing will vary along a fault in the following circumstances:

(*a*) A fault curves in such a way as to intersect in section particular stratigraphical levels more than once (Fig. 2A).

(*b*) A planar fault cuts non-planar beds so as to intersect in section particular stratigraphical horizons more than once (Fig. 2B). This configuration could be the consequence of folding preceding faulting.

(*c*) A fault which has been folded (Fig. 2C).

Situations (*a*) and (*b*) are indistinguishable in terms of the pattern of facing which results. Both give rise to abrupt changes of facing. The facing direction suddenly reverses and along certain parts of the fault *footwall facing* differs from *hanging-wall facing*. Case (*c*) on the other hand gives rise to facing variation of a continuous nature around the folds. Continuous

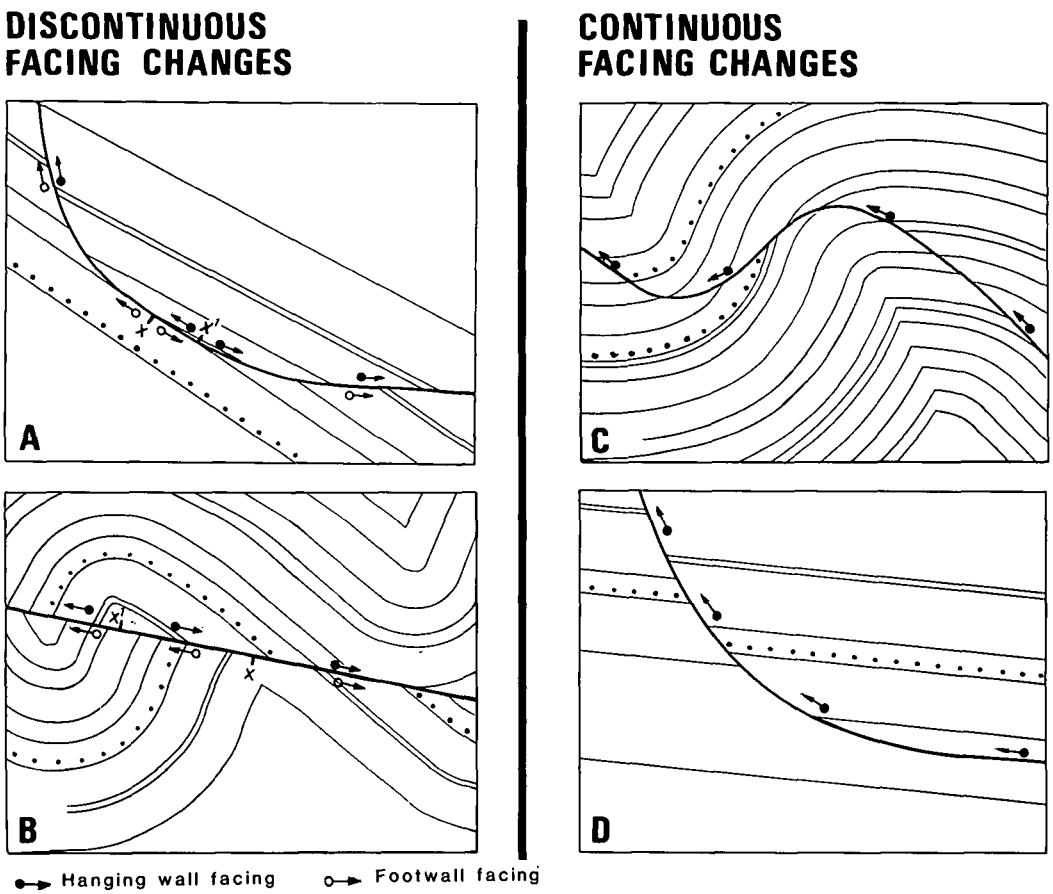

Figure 2. Fault structures which show variable facing. The points denoted X and X' mark the locations of facing reversal on the footwall and hanging wall respectively. See text for explanation.

patterns will also be caused by an initially curved fault which transects bedding in a constant sense (Fig. 2D).

In Figure 3 the facing configuration has been determined in two examples of real faults. The continuous pattern shown by the facing directions on the thrust from the Jura (Fig. 3A) is consistent with Laubscher's (1977) interpretation of this structure as a folded thrust. The discontinuous facing changes shown by the near planar thrust at Torquay, England (Fig. 3B) implies that the folding preceded thrusting.

The above examples illustrate the usefulness of facing to decipher the order of folding and faulting in complex structures. In some situations folding and faulting may be kinematically related. It has been proposed that synchronous folding in the rocks above a thrust can be produced by arching over a developing duplex (Elliott & Johnson, 1980) or by a rucking-up of the rocks in the hanging-wall produced by a sticking or slow propagation of a thrust (Coward & McClay, 1983). If the folding is limited to the hanging-wall, then folded thrusts with continuous facing changes will characterize systems thrust up in a piggy-back fashion whilst thrusted folds with discontinuous patterns (cf Fig. 3B) will typify out-of-sequence thrusting (see Butler, 1982 for terminology).

The pattern of facing can help to clarify the geometry of structures like transform faults, rotational faults, etc. The application of facing to areas where

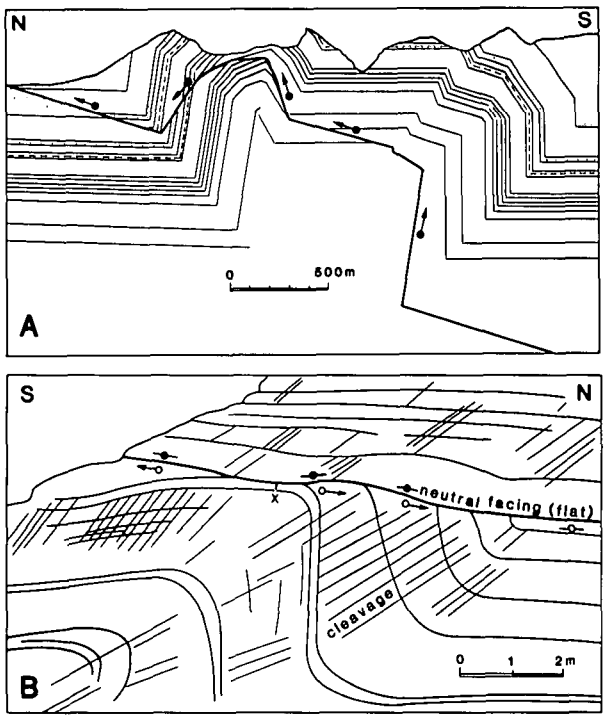

Figure 3. Examples of faults with variable facing: (A) Laubscher's (1977) interpretation of the Raimeux anticline (Jura) shows facing which varies continuously. This pattern of facing variation is typical of folded thrusts. (B) Hope's Nose, Torquay (SX 948634). The thrust shows a discontinuous facing pattern which is characteristic of thrusted folds.

faults displace an established but stratigraphically unproven rock sequence may require the use of the term 'apparent facing' to indicate the direction in the fault plane towards the structurally higher parts of the sequence.

From the foregoing discussion it is apparent that the concept of structural facing can be usefully broadened to include fault structures. In this way we obtain a practical way of describing the orientation of a fault relative to the younging direction of the stratigraphy it displaces without necessitating the introduction of a new term.

References

BORRADAILE, G. J. 1976. Structural facing (Shackleton's Rule) and the Palaeozoic rocks of the Malaguide Complex near Velez Rubio, S.E. Spain. *Proceedings. Koninklijke nederlandse akademie van wetenschappen* B **79**, 330–6.

BOYER, S. E. & ELLIOTT, D. 1982. Thrust systems. *Bulletin of the American Association of Petroleum Geologists* **66**, 1196–1230.

BUTLER, R. W. H. 1982. The terminology of structures in thrust belts. *Journal of Structural Geology* **4**, 239–46.

COWARD, M. P. 1982. Surge zones in the Moine thrust zone of NW Scotland. *Journal of Structural Geology* **4**, 247–56.

COWARD, M. P. & MCCLAY, K. R. 1983. Thrust tectonics of South Devon. *Journal of the Geological Society of London* **140**, 215–28.

CUMMINS, W. A. & SHACKLETON, R. M. 1955. The Ben Lui Recumbent Syncline (S.W. Highlands). *Geological Magazine* **92**, 353–63.

DAHLSTROM, C. D. A. 1970. Structural geology in the eastern margin of the Canadian Rocky Mountains. *Bulletin of Canadian Petroleum Geology* **18**, 332–406.

DE WIT, M. J. 1982. Gliding and overthrust nappe tectonics in the Barberton Greenstone Belt. *Journal of Structural Geology* **4**, 117–36.

ELLIOTT, D. & JOHNSON, M. R. W. 1980. Structural evolution in the northern part of the Moine Thrust Belt, N.W. Scotland. *Transactions of the Royal Society of Edinburgh: Earth Science* **71**, 69–96.

HARRIS, A. L. 1962. Dalradian geology of the Highland Border near Callander. *Bulletin of the Geological Survey of Great Britain* **19**, 1–15.

LAING, W. P. 1977. Structural interpretation of drill core from folded and cleaved rocks. *Economic Geology* **72**, 671–85.

LAUBSCHER, H. P. 1977. An intriguing example of a folded thrust in the Jura. *Eclogae Geologicae Helvetiae* **70**, 97–104.

SHACKLETON, R. M. 1958. Downward-facing structures of the Highland Border. *Quarterly Journal of the Geological Society of London* **113**, 361–92.

WOOD, B. L. 1978. The Otago Schist Megaculmination. Its possible origins and tectonic significance in the Rangitata Orogen of New Zealand. *Tectonophysics* **47**, 339–68.