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SUPERPOSED FOLDING IN REVIN BEDS NEAR DREIKAISEREICHEN, HOHES VENN (RHEINISCHES SCHIEFERGEBIRGE) [1]

by

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(3 figures and 1 table)

ABSTRACT.- Evidences are cited for the presence of superposed fold systems in a 250 metre road section of slates and quartzites belonging to Revin 4 beds near Dreikaisereichen in the core of the Venn Sattel. An inclined fold system plunging moderately to NE (Variscan?) has been superposed on earlier isoclinal folds (Caledonian?). The dominant schistosity is parallel to the axial planes of the later folds.

ZUSAMMENFASSUNG.- Es werden Beweise angeführt für das Auftreten von sich überlagernden Faltensystemen in einem 250 m langen Strassenaufschluss mit phyllitischen Tonschiefern und Quarziten der Revin 4 -Schichten nahe den Dreikaisereichen im Kern des Venn-Grossattels. Ein System geneigter (variskischer?) Falten, deren Achsen schwach nach NE eintauchen, ist älteren (kaledonischen?) isoklinalen Falten überlagert worden. Die vorherrschende Schieferung liegt parallel zu den Achsenflächen der jüngeren Falten.

INTRODUCTION

The cambro-ordovician Revin beds occupy the largest surface area within the Stavelot-Venn Massif, which is the easternmost of the few Caledonian domes within the Ardennes - the north-westernmost Variscan unit in continental Europe. The Caledonian Massifs are widely believed to have "suffered twice the vicissitudes of a major orogeny" (RUTTEN, 1969) - the Variscan orogeny having been superposed on the earlier Caledonian folds and faults.

The present paper describes the structural geology of the approximately 250 metre-long road section of Revin beds at Dreikaisereichen, about 4 km southeast of Zweifall (fig. 1a) in the northwestern flank of the Fringshaus Anticline. Among other workers, THOME (1955), GEUKENS (1957) and VOIGT (1968) discussed minor folds from different parts of the Venn Anticlinorium, while PLESSMANN (1959) described the "unusual folds" near Rötgen. In the Belgian part, ALBRECHT (1971) recognized superposed folding in the Weser dam area near Eupen.

In GEUKENS (1950) scheme of purely lithologic classification of the practically unfossiliferous Revin beds into Revin 1 (the oldest) to Revin 5 (the youngest), the outcrops under discussion here belong to Revin 4 and are also known as Lower Revin in Germany (SCHMIDT, 1956). In the present work the measurements of the structural data were collected with reference to 11 previously located survey points along the inner margin of the curved road (A to K in figs. 1,2).

MESOSCOPIC STRUCTURES

Structures ranging in scale from a few mm to a few metres are abundant in this section. There is a considerable lithologic variation within the shortest distances, and the rocks have been conveniently grouped as (1) predominantly slates, generally grey to bluish grey, and including the dark carbonaceous slates, and (2) alternations of quartzites and quartz-schists (fig. 2). Some greyish to pale-brown layers of quartzite are massive and have widths more than a metre. The primary bedding surfaces (SS) are recognizable in the thinner quartzitic layers by the colour bands and in the phyllitic slates by the presence of thin quartzose layers. Other primary features, such as, flute casts, load casts and ripple marks are also occasionally preserved, e.g. near E and G. The most dominant planar structure is, however, the secondary slaty cleavage and schistosity (S1). The prolific development of schistosity at Dreikaisereichen has earlier been noted by HESEMANN

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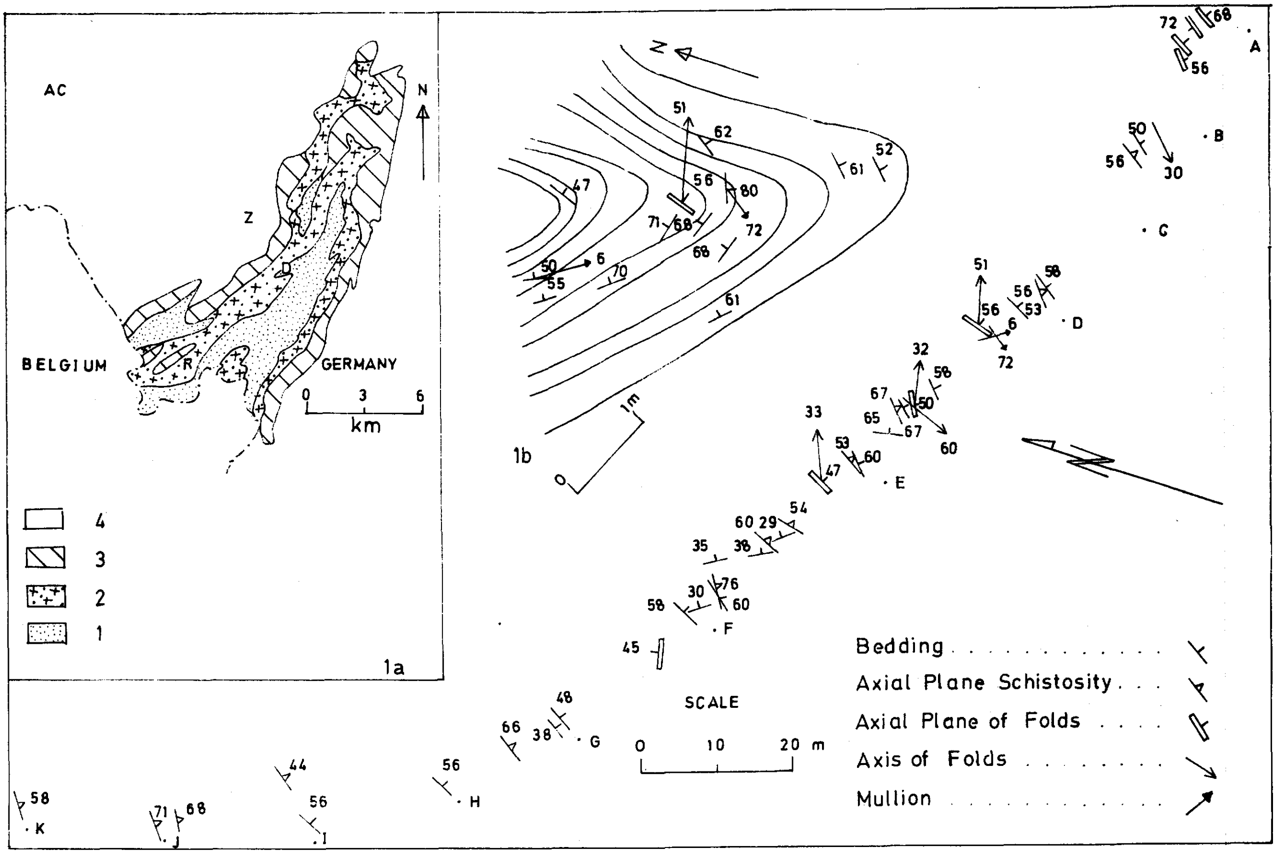

Figure 1.- Planar and linear structures in the road section near Dreikaisereichen. A to K denote 11 survey points; la depicts the regional setting of the area (modified from SCHMIDT, 1956). AC - Aachen, D - the road-section at Dreikaisereichen, R - Rötgen, Z - Zweifall. 1- Lower Revin Rv 4,2 - Upper Revin Rv5, 3 - Salm, 4 - Gedinnian and younger rocks. 1 b is the map of the major fold north of D.

(1975, figs. 2, 3). The linear structural elements include fold-axes and occasional mullions. Folds of different scales are present between A and G. Kink folds are occasionally present in slates. The more quartzose layers in slate occasionally form boudin-like structures, the surrounding clean slates flowing into the necking points.

STRUCTURAL RELATIONS

For an overall structural view, the usual map of planar and linear structures (fig. 1) has been supplemented by a profile (fig. 2) drawn along the curved road. The two figures have been drawn with the same scale and orientation, and the curved profile line has been preferred to the usual rectilinear one for a better understanding of the structure. It is apparent that the mesoscopic folds are prominent in the slaty zones, and furthermore, despite the presence of a few faults, the mesoscopic folds are more or less of same style and orientation. The two main folds from this section are compared in table 1.

Table 1.- Comparison of two major folds in the area

	Folds north of D	Folds north of E
1. Concise description*	(18,56;51-77)	(34,47;33-68)
2. Rake of fold axis on axial plane	71°	46°
3. Fold classification**	I_{ms}	I_{mm}
4. Interlimb angle	50°	55°
5. Direction of closure	SE	SE
6. Vergence	NW	NW
7. Relationship to schistosity	Parallel to the axial plane	Parallel to the axial plane

* The numbers denote strike of axial plane, dip of axial plane, amount of plunge, and direction of plunge respectively (after CHAUDHURI, 1972).

** I_{ms} denotes an "inclined fold" with moderately dipping axial plane and steeply pitching fold axis; I_{mm} denotes an "inclined fold" with moderately dipping axial plane and moderately pitching fold axis (fold terminology of FLEUTY, 1964 followed).

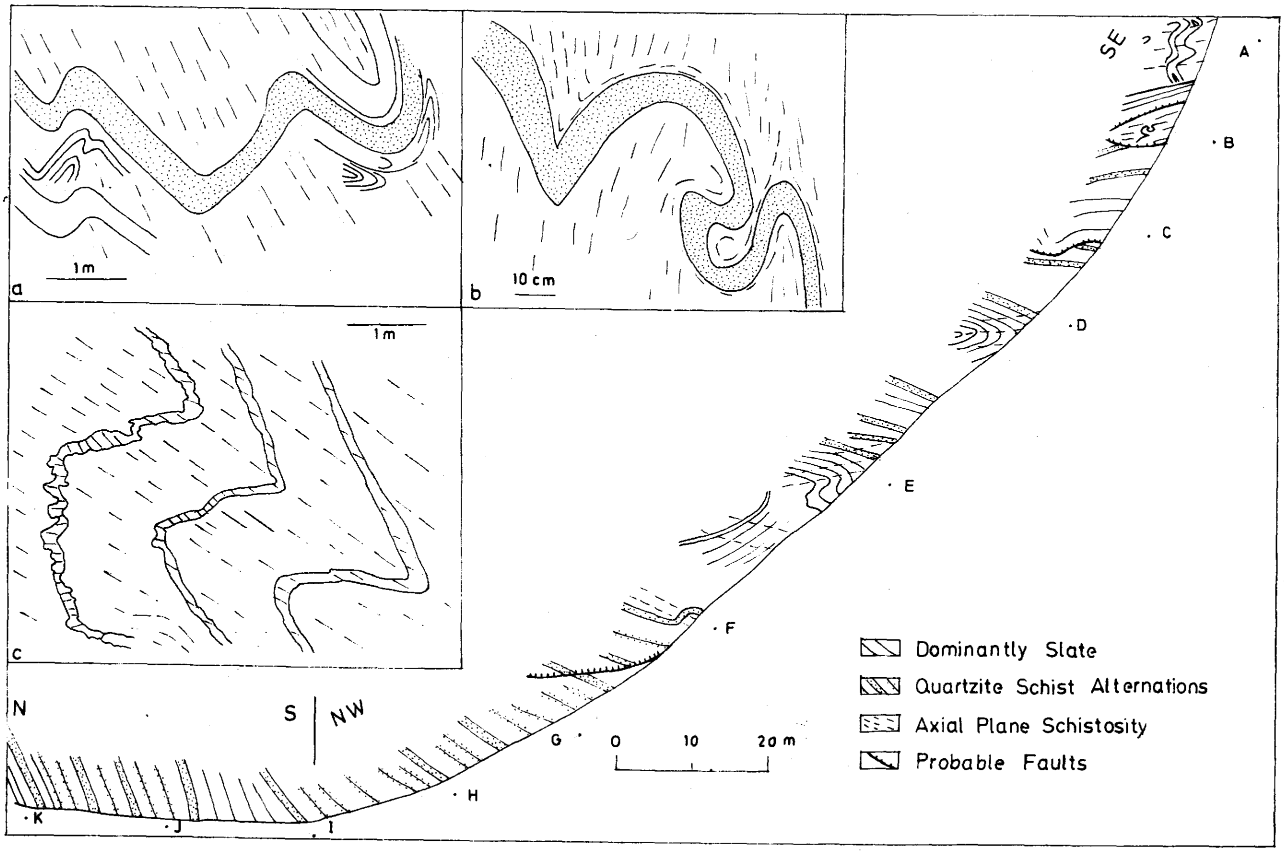

Figure 2.- Geological profile along the road-section. Insets a, b, c depict minor structures. Sketches made looking due N, N45E and N65E respectively. Explanations in text.

The dominant schistosity in this area is unquestionably parallel to the axial planes of the major folds. One prominent feature of S_1 is its occasional marked refraction within the quartzite layers in alternating quartzite-slate sequence. The schistosity is steeper in the quartzites than the surrounding slaty layers often by more than 20^o; the strike of the schistosity generally remains constant (fig. 2c). The cleavage surfaces in the more competent layers are less closely spaced and more clean-cut than those in the slates, and at some places, fine displacements are also noticed, imparting an appearance of "fracture cleavage" to such surfaces in quartzite. However, the continuity in the cleavage surfaces in the quartzites and slates proves the two to be of common origin.

In this isoclinal sequence of beds, the bedding-axial plane schistosity relations are interesting. Near E both SS and S_1 dip to SE, but the former is steeper and the younging of beds, as shown by primary sedimentary structures, is to NW, proving thereby the overturned nature of the limb. In contrast, near F, SS is gentler than S_1 and the younging, again deduced from sedimentary structures, is in the direction of dip, thus locating a normal limb. The presence of a macroscopic syncline can be postulated between E and F.

The geometry of the planar and linear structures in this area is, however, not simply explainable by a single axis of folding, because there are evidences for the presence of minor folds earlier to these major folds. Superposed structures are occasionally represented as two-lineated phyllites in hand specimens. In a larger scale, the major fold north of D (fig. 1b) shows up a set of mullions that are not parallel to the fold axis of the major fold. The mullions show varied orientations at different parts of the fold -- 6^o to E56S in the lower limb away from the nose to 72^o to S37W in the upper limb near the nose. The mullions denote the axes of an earlier fold system, and they have been folded by the major folds. The major fold itself shows steepening of its axis near the core, where a probable dome-and-basin structure caused by interference of folds of two generations is present.

Between stations A and B a number of major folds occurs, but here again the limbs contain tight

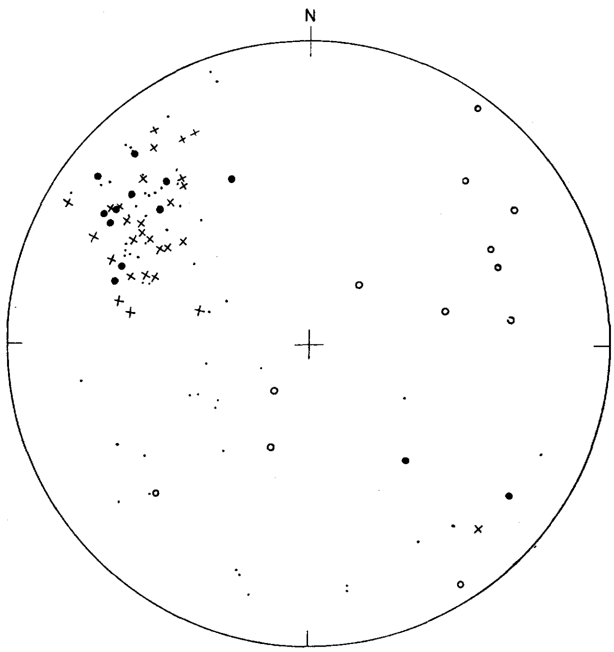

Figure 3.- Lower hemisphere projections in the equal-area net of the planar and linear structures in this section. Dots - poles of bedding, cross - poles of axial plane schistosity, filled-in circles - poles of axial planes of folds, and open circles - poles of fold axes.

isoclinal folds (fig. 2a). The attitudes of axial planes and axes of minor folds vary remarkably, sometimes within a few cms. Fig. 2b depicts the minor folds between B and C. The double closures are typical of superposed fold systems, and the rotated earlierfolds show plunges in diverse directions. Minor folds with varied orientations in juxtaposition are also seen near D, where earlier isoclinal folds have occasionally been rotated to steeply plunging upright attitudes. The present width of any limb of a fold does not represent the true thickness of that limb, but is the result of the merger of two or more limbs.

The planar and linear structures have been plotted in an equal-area net (fig. 3). The mesoscopic fold axes show divergent attitudes, while the poles of bedding describe an ill-defined girdle around a moderate northeasterly axis. The high angle between the average strike direction of the axial planes of folds and the average northeasterly direction of fold axes points to the inclined to almost reclined nature of the dominant macroscopic folding.

It may be argued that the schistosity developed as bedding plane foliation along with the first set of inclined (reclined?) folds. The superposition of the dominant, later generation of inclined folds plunging moderately to NE rotated the axes and axial planes of the early minor folds, and the schistosity was transposed parallel to the axial planes of the later folds. In slates are frequently seen the kink folds made of step-like angular monoclines, where the short and long limbs are parallel to the bedding in the neighbouring quartzite and to the axial planes of the major folds respectively.

CONCLUDING REMARKS

The exposed profile gives us an insight into the complex tectonic structures in the core of the Venn Anticlinorium, and the present work, though admittedly covering a very small area, proves the superposition of later inclined folds on an earlier isoclinal fold system in Revin beds, probably signifying the superposition of Variscan structures on Caledonian folds. A superposition of this kind would have resulted in a picturesque map pattern if continuously traceable marker horizons were present. The elucidation of the stratigraphic sequence in Revin beds is difficult despite the occasional presence of primary top-and-bottom structures because of the isoclinal nature of the fold geometry, and the difficulty is heightened further by the superposition of the inclined fold system. In such a region where large scale repetitions and inversions are likely to occur, structural history is the most dependable guide for stratigraphic work. A systematic structural mapping and analysis throughout the Revin beds may lead to a proper stratigraphic classification of Revin beds.

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