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Faulting of the Witteberg Group Rocks, Steytlerville, Eastern Cape.

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ABSTRACT

A structural study of Witteberg Group Rocks was conducted along the Soutkloof River, approximately 14 km east of Steytlerville, Eastern Cape Province of South Africa. Here a north to south geotraverse was studied in an attempt at unravelling the structural geology of the rocks belonging to the Upper Devonian to Lower Carboniferous Witteberg Group (Upper Cape Supergroup). These rocks are mostly arenaceous and include quartzite, sandstone, siltstone and shale which have been folded, faulted and metamorphosed. Thrust, normal and strike-slip faulting occur in the area. Shallow south dipping low-angle thrust fault planes are displaced by steep south-dipping thrust planes and subordinate north-dipping backthrusts. Displacement along thrust planes is predominantly northwards. Steeply dipping thrust fault planes are often reactivated by east-west striking normal faults. Strike-slip faulting post dates all structural features and displaces normal and thrust fault planes. Open to tight folds are present and are mostly north-vergent and often steepened or truncated by steep south-dipping thrust fault planes. South-vergent folds are related to backthrusting and post-fold faulting. The study has revealed that the current geologic map and the local stratigraphy were compiled without recognising major structural features such as thrust, normal and strike-slip faulting, and its validity is therefore questioned. Extensive faulting suggests that the conventional stratigraphic interpretation of the Witteberg Group strata should be revised.

Key words: Witteberg Group, Thrust fault, Normal fault, Strike-slip fault

INTRODUCTION

Rocks of the Weltevrede, Witpoort and Kweekvlei Formations (Witteberg Group) were studied along a north to south section along the Soutkloof River, approximately 14 km east of Steytlerville (Fig. 1). Orientation data of various structural features, including, faulting, folding, cleavage and jointing were collected throughout the area, of which faulting was considered to be the most important.

Thrust faults are present in the area in the form of shallow, south dipping low angle and steep, south dipping fore-thrust planes, whereas north-dipping back thrusts are not that common. Steeply dipping normal faults post-date thrust faults, often reactivating pre-existing thrust fault planes. Strike-slip faulting occurs throughout the study area and post-dates all other faulting (Brunsdon, 2006).

Rocks of the Witteberg Group (Table 1) are mostly arenaceous (Table 2) and include quartzite, sandstone, siltstone and shale. Rocks of the Weltevrede Formation comprise micaceous, flaser-bedded and lenticular siltstones and shales intercalated with fine-grained siliceous sandstones (Toerien and Hill, 1989). Trace fossils are common on bedding planes, while oscillation ripple marks are occasionally present (Johnson, 1976). According to Whittingham (1987) a characteristic fine-textured, pale-grey, yellowish-weathering limestone occurs in the Weltevrede Formation. These limestone bands are usually much thinner than 1 m and usually concordant with the bedding.

The Witpoort Sandstone Formation is the most prominent formation of the Witteberg Group and consists of more than 90% sandstone. It is divided into two members: Rooirand and Perdepoort. The basal Rooirand Member appears pinkish grey on weathered surfaces and comprises medium- to thick-bedded quartzitic sandstone with thin lenticular shale and flaser-bedded siltstone intercalations (Toerien & Hill, 1989). Internal structures include parallel flat-bedding, cross-bedding and micro-crosslamination (Johnson, 1976).

The Perdepoort Sandstone Member consists entirely of quartzitic sandstone and appears white and massive in outcrop. It is exceptionally clean and relatively coarse grained (Toerien & Hill, 1989). Internal syndepositional structures include horizontal or sub-horizontal flat-bedding, inclined bedding and less well developed low-angle cross-bedding than occurs in rocks of the Rooirand Member (Johnson 1976).

The Kweekvlei Formation consists of dark coloured, purplish-grey micaceous shale, lenticular flaserbedded siltstone and shale and thin quartzitic sandstone (Johnson, 1976; Whittingham, 1987). According to Whittingham (1987) the Kweekvlei Formation appears very similar to the shales and sandstones of the Weltevrede Formation.

Rocks of the Witteberg Group have been folded extensively and often a clear relationship exists between folding and faulting (Booth 1996, 1998, 2002).

The presence and complex relationship of faulting has largely gone unnoticed and does not reflect on the current geological map or in the local stratigraphy. A detailed study of faulting of the Witteberg Group Rocks is imperative to understand the local stratigraphy, as thrust faulting often modifies normal stratigraphic order by repeating layers and causing less competent layers to disappear completely.

FAULTING

Faulting is present throughout the study area. Thrust faults were grouped into older low angle thrusts and younger steeper dipping thrusts. Normal and strike-slip faulting occurred subsequently to thrusting. Thrust faults in the area dip to the south and are commonly associated with folding, often utilising the limbs of folds as planes of movement (Fig. 2).

Limbs of folds were tightened during faulting and in some cases fold limbs were removed during faulting. The effect of faulting in folded areas is related to the competency and lithology of the folded layers. More resistant arenaceous layers are often cut by fault planes, whereas less resistant argillaceous layers are often obliterated completely during a faulting event.

A large normal fault system (Grootrivier East) occurs to the north of the study area. The Jackalsbosch thrust fault system occurs less than half a kilometre to the south of the Grootrivier East Fault. The area in between these two major fault zones illustrates clearly the relationship amongst various types of faults (Fig. 3).

Low angle south dipping faults (often parallel to bedding) are displaced by steeper south dipping thrust faults, which have a similar orientation to the thrust faults of the Jackalsbosch fault system. A north dipping back thrust fault post-dates the low angle faulting, but possibly predates the steeper thrust faults. Normal faults displace the thrust faults, and in some cases normal faults might be utilising and re-activating pre-existing steeper dipping thrust fault planes.

Strike-slip faulting is present in the area displacing thrust and normal faults. In Figure 4 it is clearly visible how the Grootrivier East and Jackalsbosch fault zones have been displaced by strike-slip faulting. It is not always possible to determine the sense and amount of displacement along these faults in the field.

DISCUSSION AND CONCLUSIONS

The presence of faulting plays an important role in the stratigraphy of the Witteberg Group rocks. Less resistant argillaceous horizons are obliterated by faulting, while more resistant aerenaceous horizons are repeated due to thrust stacking. In most cases there are not suitable marker horizons present that can be used to determine the amount of movement along faults.

Thrust faulting in the area might be related to the Baviaanskloof thurst fault which occurs about 20 km to the south of the study area (Booth *et al*., 2004).

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Table 1. Stratigraphy of the Witteberg Group in the Eastern Cape (after Broquet, 1992; SACS, 1980), note the shaded area represents the rock outcrops of the study area.

GROUP	SUBGROUP	FORMATION	MEMBER	AGE
WITTEBERG	KOMMADAGGA	Dirkskraal Soutkloof Swartwaterpoort/Miller		~330 Ma
	LAKE MENTZ	Waaipoort Floriskraal		CARBONI- FEROUS
		Kweekvlei		
		Witpoort	Perdepoort Rooirand	360 Ma
		Weltevrede		~375 Ma

Table 2. Stratigraphical sequence of the Cape Supergroup (after Booth and Shone, 2002)

Group	Age (Ma)	Lithotype	Deposition Environment
Witteberg	340-375	Quartzites & Shales	clastic, shoreline deposits
Bokkeveld	375-390	Shales & Quartzites	clastic, shallow marine deposits
Table Mountain	390-520	Quartzites & Shales	clastic, shallow marine and shoreline sediments

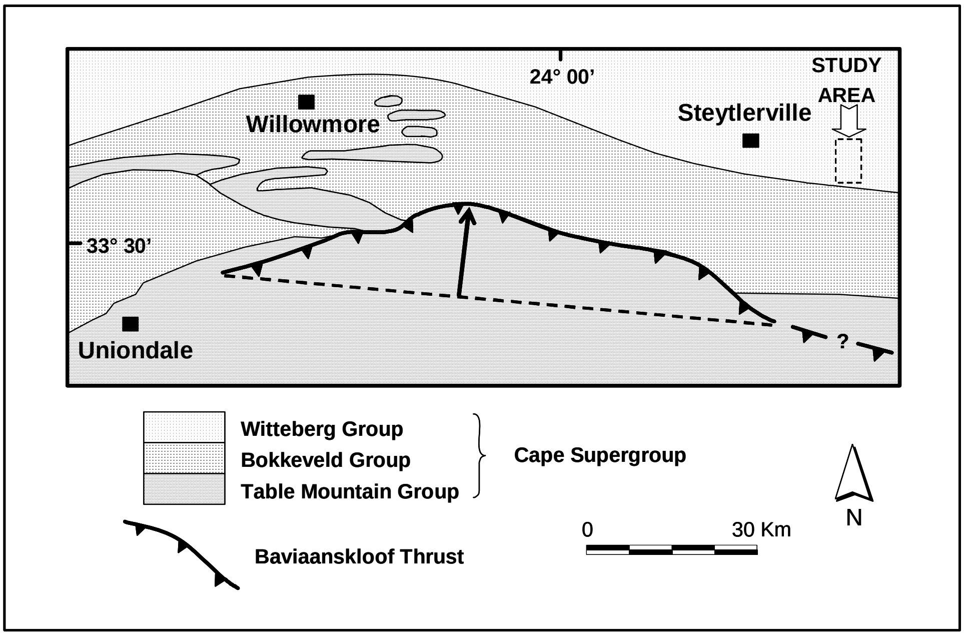

Figure 1. Regional setting for the Baviaanskloof thrust in relation to Steytlerville and the study area (modified after Booth, Brunsdon & Shone, (2004), Figure 15, pg 220).

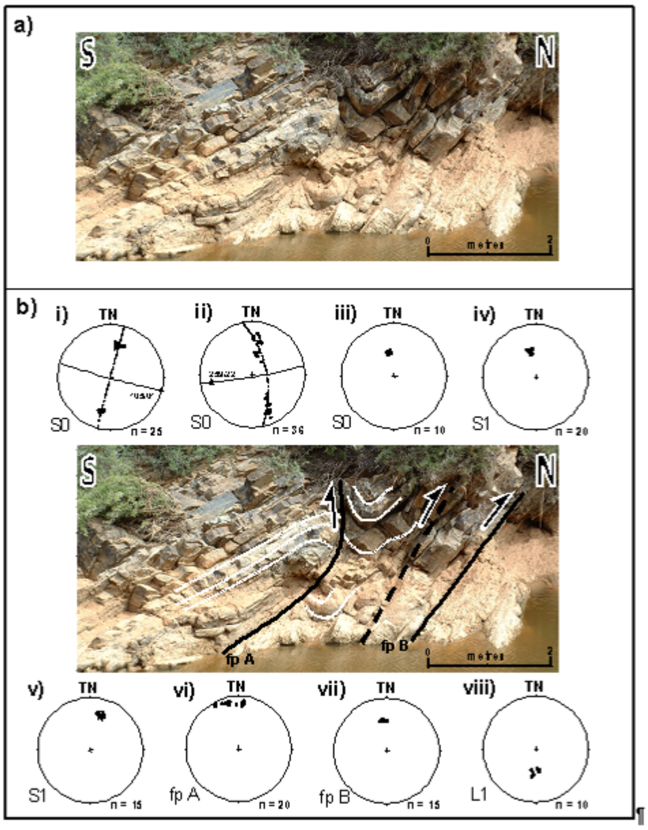

Figure 2. a) Photograph looking west into folding and faulting outlined in (b), b)Outline of structure from above. Thrust faults (fp A & fp B) are indicated by solid black lines and an inferred thrust fault by a dashed black line. Limbs of anticline and syncline are indicated by white dotted lines. Note how limbs of folds are displaced by thrust faulting. Stereograms are as follows: i) Anticline, ii) Syncline, iii) bedding planes to the north of the syncline, iv) Cleavage in shales north of the syncline, v) Axial planar cleavage measured at the anticline, vi) fault plane A, vii) fault plane B, viii) Lineations measured on fault plane B. All stereograms are Schmidt Nets, and show poles to planes, except for the lineations (L1) which were plotted on a Wulff Net. (After Brunsdon, 2006)

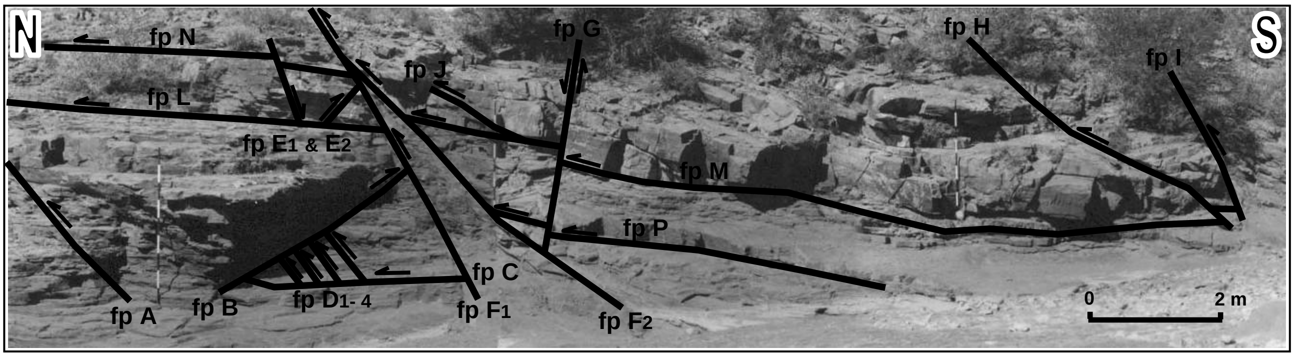

Figure 3. Sketch made from composite photographs taken at station 15 showing the relationship between shallow south-dipping thrust faults, steep south-dipping thrust faults, a north-dipping backthrust fault and steeply dipping normal faults (after Brunsdon, 2006)

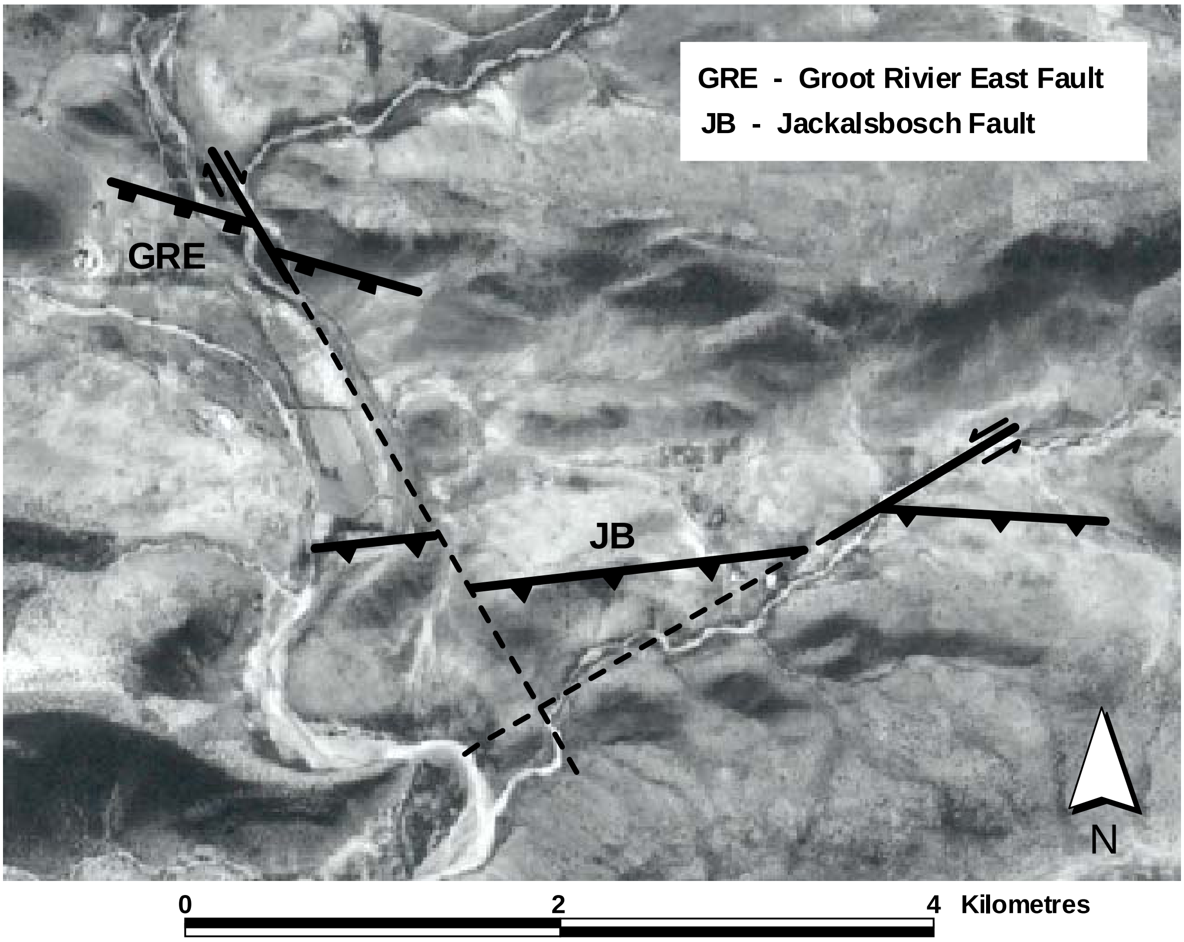

Figure 4. Aerial photgraph showing displacement of the Groot Rivier East and Jackalsbosch Faults by en echelon strike-slip faulting. Note how rivers flow sub-parallel to the inferred continuation of strike-slip fault planes (dashed lines) (after Brunsdon, 2006).