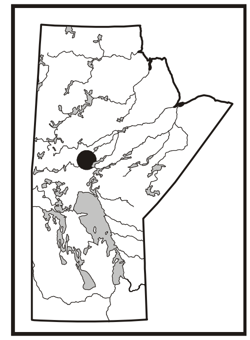
GS-9

STRUCTURE OF OSPWAGAN GROUP TURBIDITE AT SETTING LAKE (NTS 63O/2)



by E.B. Ducharme[1] and H.V. Zwanzig

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SUMMARY

Detailed mapping of a small, critical area in central Setting Lake has shown that the upper part of the Ospwagan group, though folded, forms an overall northwest-facing stratigraphic succession within parts of the Setting formation and Bah Lake formation. Among the results of three deformation phases (D_2 to D_4), S_2 provides the regional high-grade foliation and F_3 the dominant major and minor folds. The F_3 folds are upright, moderately northeast-plunging isoclines that contain relicts of southerly-verging F_2 minor folds. Late structures include mylonite, and F_4 intrafolial to sheath folds that indicate southeast-side-up slip.

INTRODUCTION

Several small islands in the central part of Setting Lake are underlain by Ospwagan group turbidite with well preserved graded bedding and several ages of secondary foliation suitable for detailed structural analysis. The islands, encompass an area of about 1 km^2 that was mapped at a scale of 1:4000. Tops were recorded where several beds were observed to face in the same direction, and the resulting axial traces of major folds were drawn on the map. An emphasis in this work was placed on determining regional stratigraphic facing by recognizing the topping of contacts with a pelitic member to the southeast and the Bah Lake formation basalt to the northwest. The relationship between bedding, secondary foliations and minor folds was recorded, particularly in the major hinges, to determine a structural history. Structures were also recorded in a mylonite zone in the north-central part of the area to asses its relation to the Setting Lake fault zone, which lies directly to the northwest.

STRATIGRAPHY

The study area lies in the upper part of the Ospwagan group southeast of the Setting Lake fault zone (Fig. GS-6-1b, this volume) and south of the probable sheared unconformity with the Grass River group (Zwanzig, 1998). Although the rocks in the area are tightly folded, the consistent northwest tops in the long limb of the folds and at the unit contacts indicate that the stratigraphic section has an overall northwest facing. The base of the section is ferruginous siltstone, the main part comprises conglomeratic to pelitic greywacke-turbidite, and the top is pillow basalt. The sedimentary rocks belong to the Setting formation (Os2) and the volcanic rocks to the Bah Lake formation (Oa1, see Zwanzig, GS-6, this volume). Although metamorphic grade is high with silimanite+muscovite locally present, the prefix 'meta' is not used in the following unit descriptions.

Setting Lake formation (Os)

Ferruginous siltstone (Os2a)

About 60 m of ferruginous siltstone is exposed on the southeast corner of the largest island and outcrops on a reef southeast of the study area (Fig. GS-9-1). A few layers, 2.5 - 4.5 m in thickness, occur within the overlying greywacke. The unit weathers medium grey to brown with conspicuous rusty iron-sulphide staining and a medium- to dark-grey fresh surface. The upper contact of this unit with the greywacke siltstone is gradational through light grey beds of fine-grained sandstone or chert that are interlayered with both units. The stratigraphic correlation of unit Os2a with the type section at the Pipe II is uncertain (Bleeker, 1990). The unit is here assigned to Os2 because thin interbeds of ferruginous siltstone occur in the main greywacke (Os2b).

Greywacke siltstone and pebbly greywacke (Os2b)

Well bedded turbidite was estimated to have a thickness of 160 m by unfolding the section. However, guided by the shape of conglomerate clasts (average Y:Z = 5.6), we estimate the original stratigraphic thickness as 400-500 m.

The turbidite displays Bouma divisions and weathers light grey (quartzose divisions), dark grey (siltstone) and dark brown (pelite). Sedimentary structures include normal grading (Fig. GS-9-2), flame structures, shaly rip-ups, and rare parallel laminated and cross-laminated Bouma divisions. These structures serve as facing criteria to delineate major folds (Fig. GS-9-1). Early folds may be synsedimentary or F_1 structures (Fig. GS-9-3).

Pebbles and cobbles comprising chert, quartzite and rare mafic rock occur in different parts of the unit, but are coarsest (<20 cm) at 50 m above the ferruginous siltstone and at the top of the greywacke in the north. The coarse clasts generally show coarse-tail normal grading, most common in the lower part of the beds but locally throughout them.

Anthophyllite schist

One small section of a single island contains light grey to a medium-brown weathering anthophyllite schist forming an isolated body in the greywacke-siltstone. Radiating needles of anthophyllite have a millimetre to centimetre grain size and fine-grained sulphides are locally visible.

Bah Lake formation (Oa)

The most westerly island in the group is underlain by northwest-facing basalt of the Bah Lake formation. The unit overlies northwest-facing Ospwagan group greywacke (Os2); the basal contact is not exposed and may be faulted. Nevertheless, sills with the same geochemical composition as the basalt (Zwanzig, unpublished data) intrude both the basalt and the underlying greywacke. The sills are interpreted to be subvolcanic and provide a link between the sedimentary and the volcanic formations. The flows are moderately to highly deformed, and fractured, and display alteration associated with late fluids. Facing directions were identified from flattened pillows and a 3 m thick massive flow that grades from komatiitic to 'normal' basalt. Brown weathering rock interpreted as hyaloclastite and pale grey chert occur at the top of the massive flow.

Dykes

Several dyke types intrude the Ospwagan group including gabbro and pyroxenite with a similar compositional range and presumable age as the Bah Lake formation. Younger dykes include mafic to lamprophyric bodies and pegmatite.

Leucogabbro to lamprophyre dykes vary from aphanitic to porphyritic in texture. Some are interpreted to be lamprophyre based on their elevated biotite content and locally present biotite phenocrysts (<10 mm). Most dykes are subparallel to bedding and unit contacts. Their thickness varies from 15 cm to several metres; the most northerly dykes are thicker and more deformed.

STRUCTURE

Good shoreline exposures over a structural thickness of 400 m, and an abundance of known facing directions provide the basis for a structural map (Fig. GS-9-1) and structural analysis (below). The most apparent feature is the overall northwest facing of the stratigraphic succession at the top of the Ospwagan group. Three sets of secondary foliations and three phases of minor folds are recognized, consistent with the D_2 to D_4 structures in the Setting Lake area proposed by Zwanzig (1998).

F_2 folds, S_2 regional foliation and veining

Aligned biotite and thin veins of quartz ± feldspar form a regional

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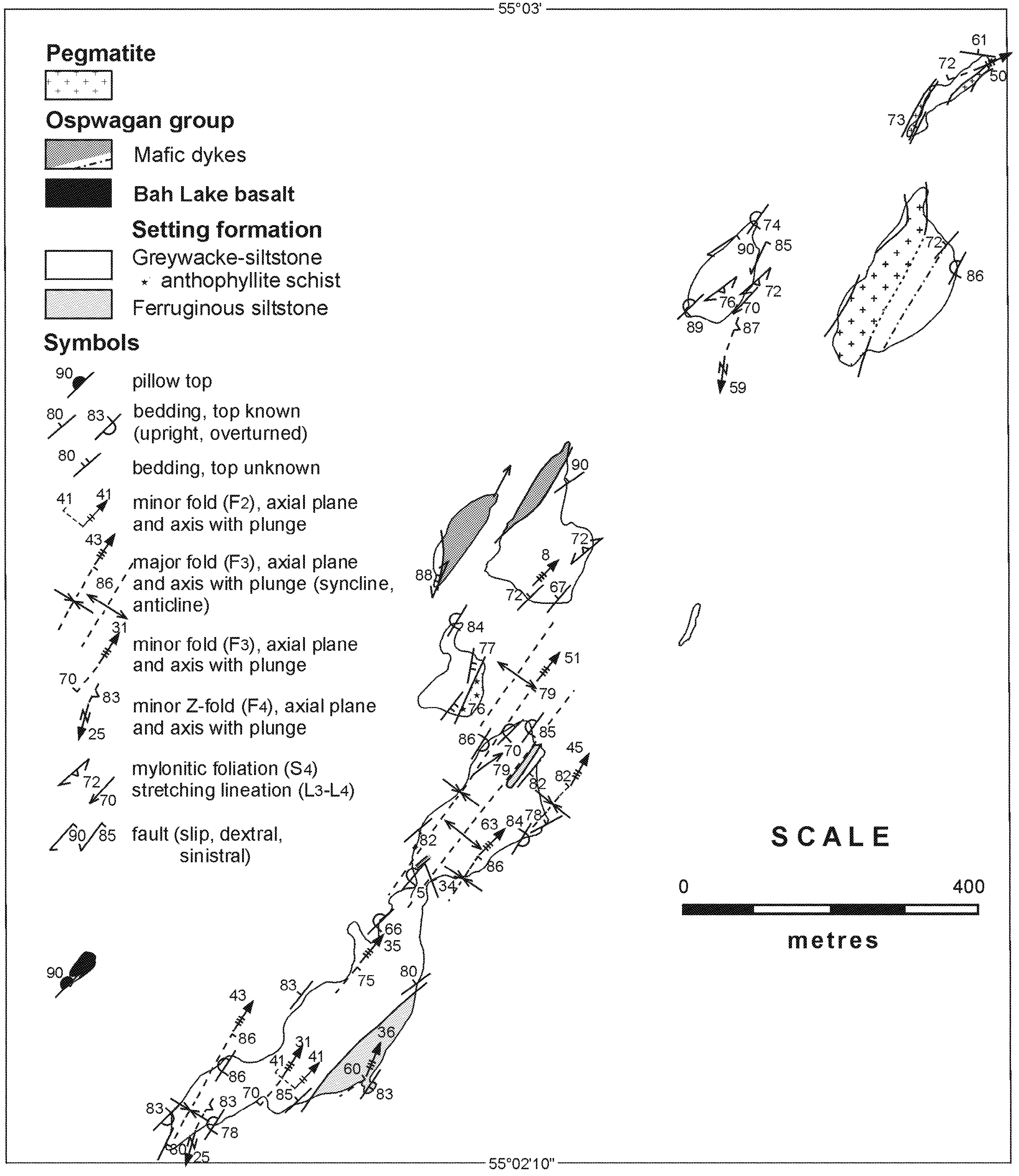

Figure GS-9-1: Map of central Setting Lake area showing the upper part of the Ospwagan group with three generations of structures.

foliation that is similar to S_2 elsewhere in the supracrustal rocks of the Setting Lake area (Zwanzig, 1998). The veins are generally less than 1 cm thick and commonly boudinaged. In siltstone and mudstone, S_2 forms a biotite segregation at a 2-15 mm scale. On the southeast corner of the largest island, F_2 intermediate-scale reclined folds have an axial-planar cleavage preserved as biotite segregations (Fig. GS-9-4), even where these structures are refolded in F_3 upright folds with a weak new axial planar S_3 foliation. The dip of the preserved S_2 foliation, the F_2 axial plane and the constant plunge of the overprinted F_3 folds indicate that the D_2 plane of deformation probably dipped gently or moderately north. Small recumbent F_1 or F_2 folds occur in a gently northeast-plunging F_3 fold hinge that has no overprinted S_3 foliation. It is important to note that, unless some of the F_3 folds have been misinterpreted, there are no tight major F_1 or F_2 folds in the area. This observation is consistent with the upright

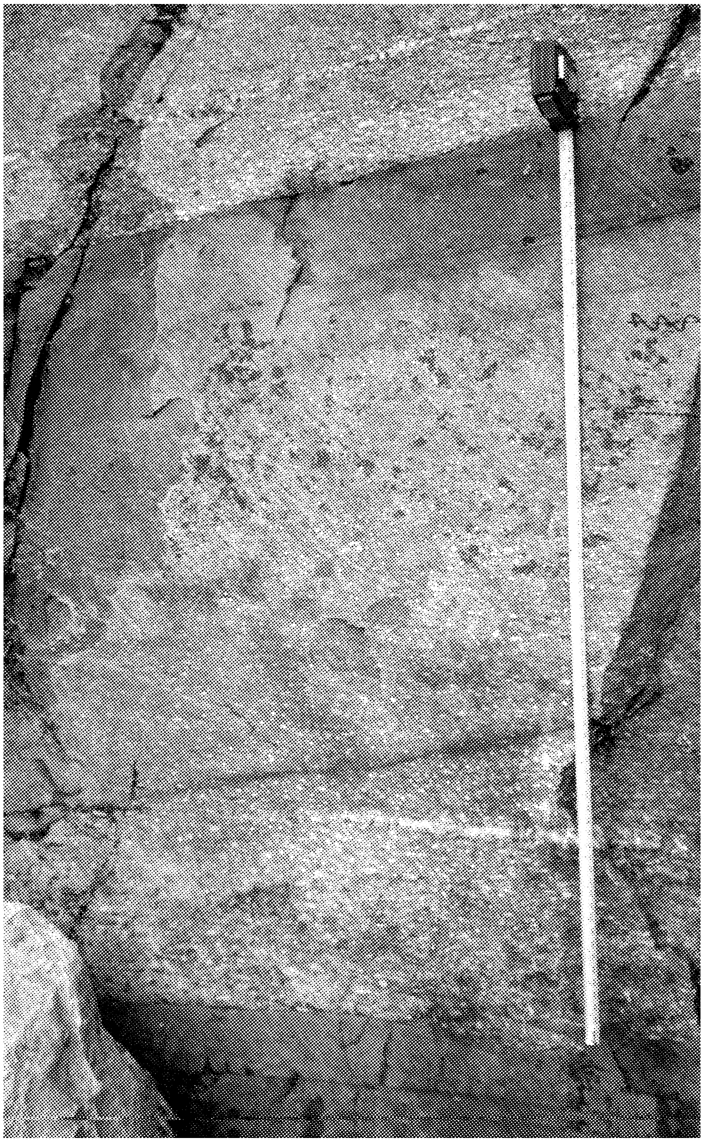

Figure GS-9-2: Normal grading, as in this 75 cm thick (deformed) greywacke bed, from small pebble- to silt-size, was used to determine stratigraphic facing and the trace of major folds.

northeast-trending F_3-F_4 syncline mapped in the Bostrom Lake area (Zwanzig, GS-6, this report)

F_3 folds and S_3 foliation

The main structural elements mapped in the upper part of the Ospwagan group in the study area are interpreted to be D_3 structures. In the area of tight folding, at the north end of largest island, S_2 is folded or transposed by a strong S_3 foliation with rare parallel veins (Fig. GS-9-5). The F_2 folds on the southeast part of the largest island are refolded by (i) early F_3 structures without axial planar cleavage, and (ii) more upright late F_3 folds with a weak axial planar S_3 biotite foliation. The transition in structural style suggests protracted F_2-F_3 deformation.

The mappable major folds are interpreted to be F_3 because typical F_3 minor folds are most abundant in the major hinge areas and change from S to Z asymmetry across the major synclinal traces, i.e., with the change from southeast- to northwest-facing beds. These F_3 axial planes are 30-60 m apart, are parallel, and strike 035°. The folds are isoclinal and upright, with steeply dipping (85° southeast) axial planes. Hinges plunge northeast, generally at 30-50°, but locally shallower. The thicker limbs and wider homoclinal panels (probably 40-120 m thick) face northwest and demonstrate that the folds are asymmetric. The isoclinal style is probably a result of flattening during D_4.

F_4 intrafolial to sheath folds and S_4 cataclastic foliation

The F_2 and F_3 structures were further tightened during the development of a greenschist-facies S_4 foliation. Micofabrics indicate that S_2-S_3 was overprinted by a subparallel spaced (strain-slip) cleavage in which the high-grade mineral assemblages were retrogressed to greenschist-facies assemblages on paper-thin surfaces. Quartz veins cutting F_3 folds were folded in turn by small F_4 folds. Pegmatite in the northern islands also cuts the F_3 folds but is affected by the last stages of the latest deformation.

One of the islands in the north is strongly affected by F_4 structures. There, the mylonitic foliation forms a >30 m wide high-strain zone with abundant south-plunging Z-shaped intrafolial folds and a steeply south-plunging stretching lineation. Closed structures with undetermined plunge are interpreted as sheath folds (Fig. GS-9-6). The measured structures indicate southeast-side-up slip with a small sinistral component. They may be somewhat older than late brittle faults and shear zones that have equally abundant indications for dextral and sinistral slip (Fig. GS-9-7), like minor faults in the Setting Lake fault zone (Zwanzig, unpublished data).

REGIONAL IMPLICATIONS

The overall northwest-facing sedimentary succession is consistent with a simple structural style of basement domes and Ospwagan group synclines and basins (Zwanzig, GS-6, this report). This observation lends support for drawing a compilation map with a simple style at central Setting Lake (Macek et al., GS-4, this report).

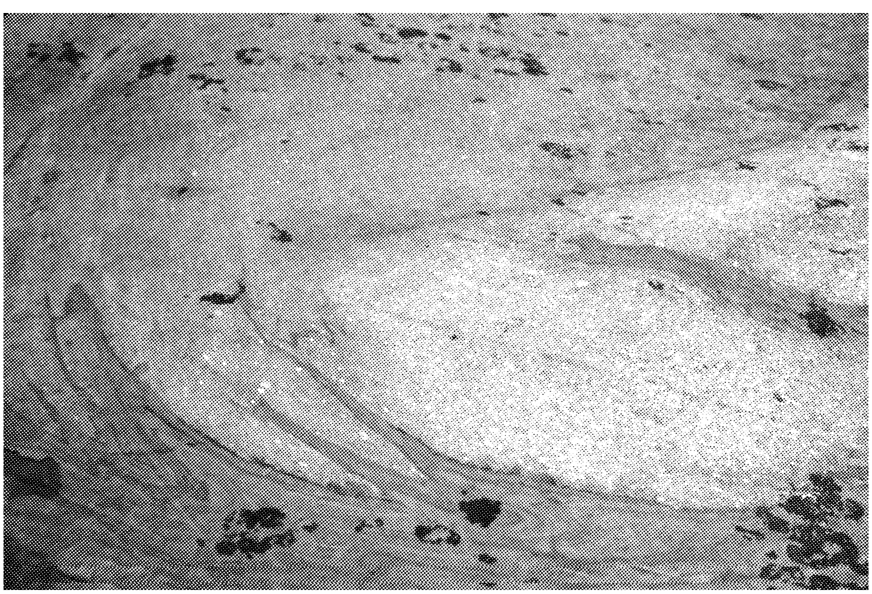

Figure GS-9-3: Possible synsedimentary or F_1 minor folds in the shaly top of a tubidite bed. The tape is 10 cm long.

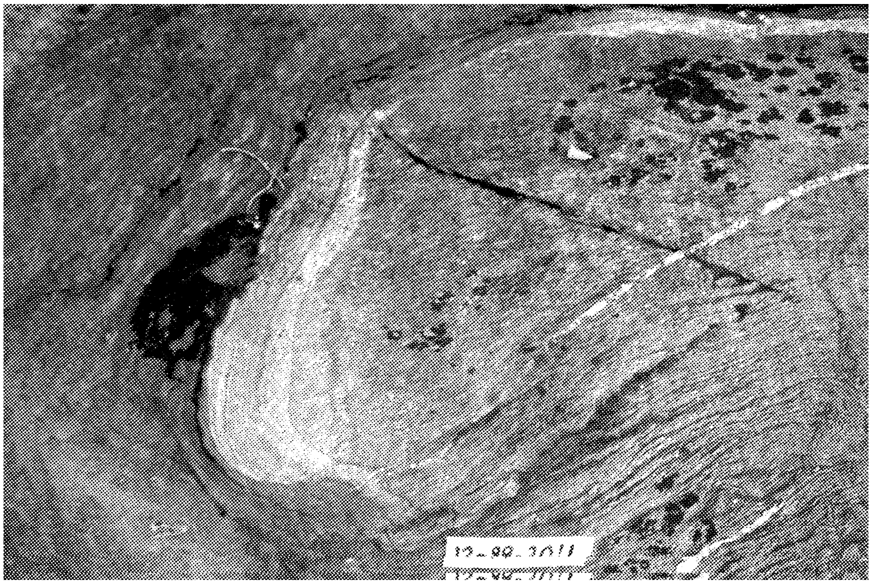

Figure GS-9-4: Regional foliation (S_2) is axial planar to local F_2 minor folds in bedding, cut by a vein and deformed by a small S_3 fold (upper right of 10 cm long tape).

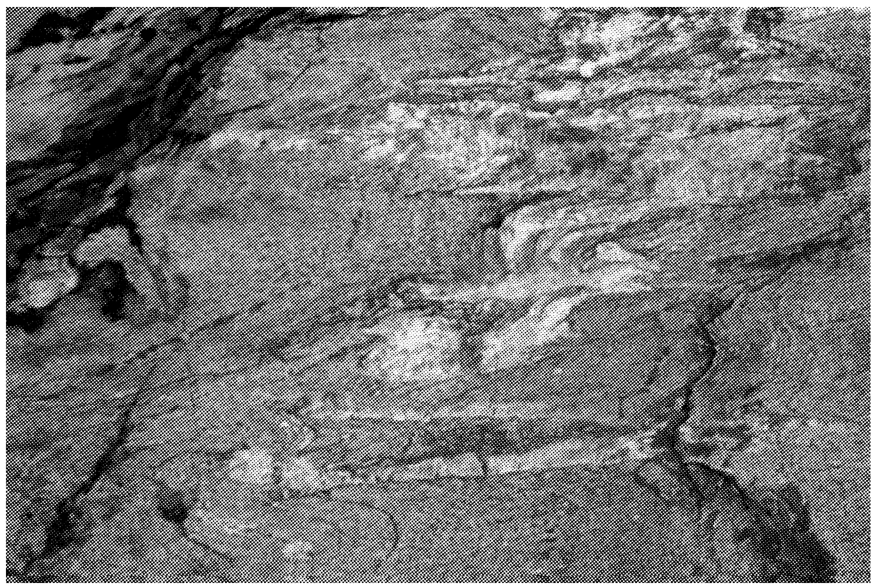

Figure GS-9-5: S_3 foliation (subparallel to 10 cm long tape) is axial planar to F_3 folds that overprint S_2 (perpendicular to tape) and partly transpose a vein originally parallel to S_2.

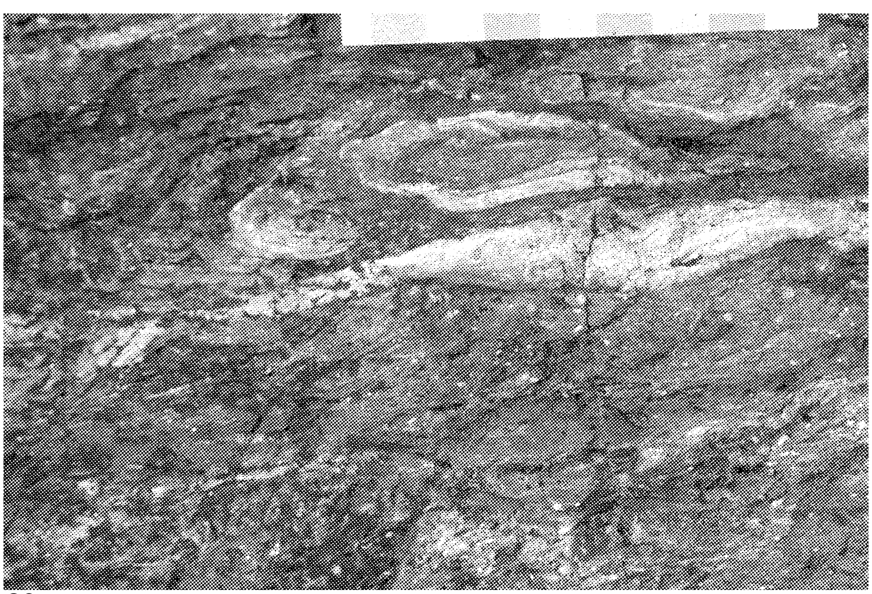

Figure GS-9-6: Probable F_4 sheath fold (below 8.5 cm card) in mylonitic pebbly greywacke.

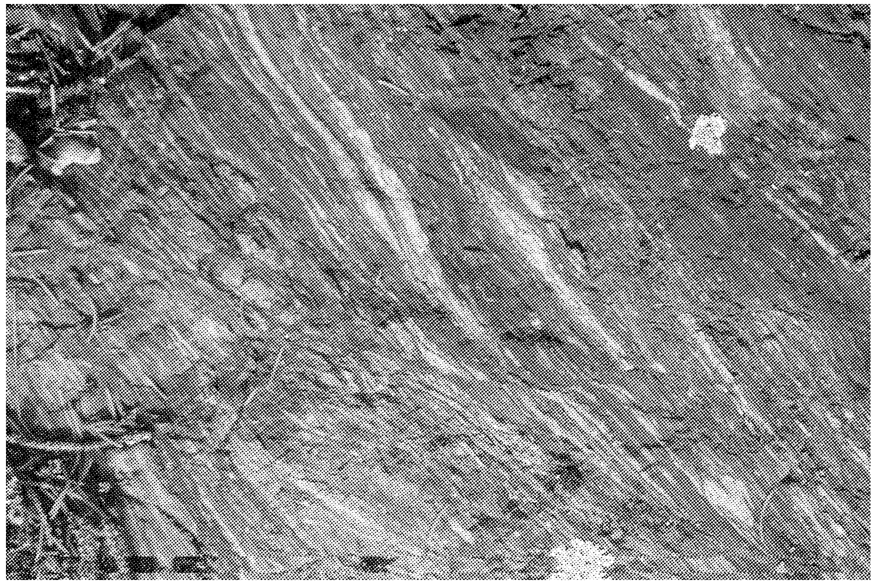

Figure GS-9-7: Sinistral shear bands (parallel to card) in mylonitic greywacke.

ACKNOWLEDGEMENTS

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REFERENCES

Bleeker, W. 1990: Evolution of the Thompson Nickel Belt and its nickel deposits, Manitoba, Canada; Ph.D. Thesis, University of New Brunswick, Fredericton, 400 p.

Zwanzig, H.V. 1998: Structural mapping of the Setting Lake area (parts of NTS 63J/15 and 63O/1, 2); *in* Report of Activities, 1998, Manitoba Energy and Mines, Geological Services, p. 40-45.