Preliminary Bedrock Geology of the Lucasville-Lake Major Area, Central Meguma Mapping Project, Central Nova Scotia

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Introduction

Detailed (1:10 000 scale) geological mapping of the Meguma Group has been undertaken by the Nova Scotia Department of Natural Resources on NTS map sheets 11E/04 and 11D/13 (Fig. 1) as part of the Central Meguma Mapping Project. Preliminary mapping results for several areas from the Central Meguma mapping project have been presented in earlier reports (eg. Horne, 1993, 1995; Horne *et al.*, 1997; Ryan, 1994; Ryan *et al.*, 1996) and open file maps for some map sheets (1:10 000 scale) have been released (Fig. 1b).

The following report presents a preliminary interpretation of the geology of the Lucasville, Middle Sackville and Waverley map sheets on NTS sheet 11D/13 (Figs. 2, 3) based on geological mapping during the 1997 field season. The mapped area is underlain primarily by the Cambrian-Ordovician Meguma Group, with a portion of the Late Devonian (ca. 370 Ma) Musquodoboit Batholith exposed at the eastern end of the area (Figs. 2, 3). Although most of the area is covered by a variable thickness of glacial deposits, outcrop distribution is reasonable for 1:10 000 scale mapping, with the best exposures along roads, streams and lake shores. However, the northwestern part of the Middle Sackville map sheet is completely blanketed by a thick cover of red, muddy till (Fig. 3) that extends northward to the area west of the Kinsac Pluton (Fig. 2).

Stratigraphy

The stratigraphy of the Meguma Group in the Central Meguma Mapping Project area, including stratigraphic subdivisions within the area and correlation with other areas of the Meguma Group, has been described within the reports mentioned above. Stratigraphy within the mapped area consists of lower, sandstone-dominated Goldenville Formation and overlying slate-dominated Halifax Formation. The Goldenville Formation is undivided within the mapped area and the Halifax Formation has been subdivided into the lower Cunard member and overlying Glen Brook member. This stratigraphy largely correlates with that defined in the adjacent area to the north (Horne *et al.*, 1997), however the Beaverbank member, which locally occurs at the base of the Halifax Formation elsewhere, was not recognized within this mapped area. The following is a description of the stratigraphy in the mapped area.

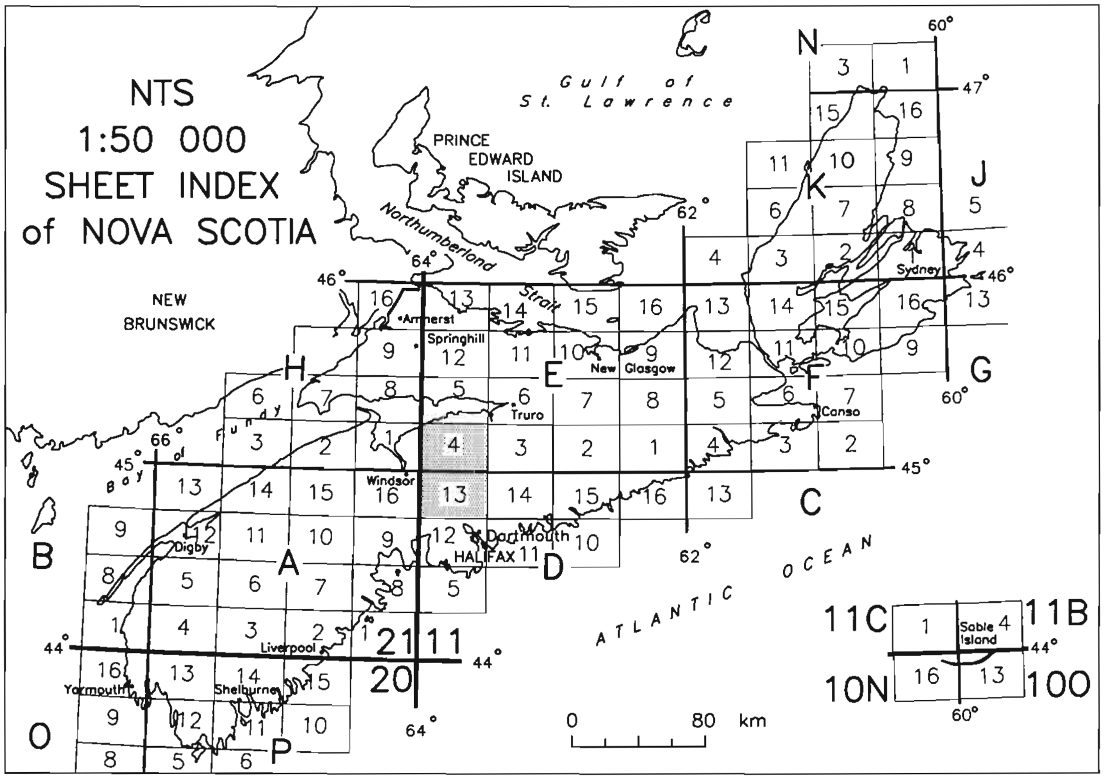
Goldenville Formation

The Goldenville Formation in the area consists of thickly-bedded metasandstone interbedded with minor metasiltstone and rare slate. Metasandstone beds typically range from < 0.5 m to several metres in thickness, however, loeally, sections of amalgamated metasandstone beds, without any distinct fine grained beds, are up to tens of metres in thickness (Fig. 4). Sedimentary structures are not common within matasandstone. They are generally restricted to planar laminations and, less commonly, crossbedding, although well developed and abundant groove structures occur locally on the bottom of metasandstone beds. Manganese concretions occur locally and coarse (1-4 cm) pyrite cubes are locally concentrated within individual metasandstone beds.

Metasiltsone beds range from a few centimetres to > 2 m in thickness, but are typically < 0.5 m thick. The metasiltstone is greenish and commonly characterized by planar and crosslaminations at the top of beds. Slate is rare and is generally green or grey in colour. Cleavage in the metasiltstone varies from a well developed, slaty cleavage to a spaced cleavage, reflecting variation in grain size.

There is considerable variability in the ratio of metasandstone to metasiltstone and slate within the Goldenville Formation of the area. However, this variation occurs within individual outcrop (eg. Figs. 4a, b) as well as between outcrops and there was no obvious systematic variation in the percentage of metasandstone recognized which would allow map units to be defined (cf. Ryan *et al.*, 1996). As discussed by Horne *et al.* (1997), the lack of systematic stratigraphic variation within the Goldenville Formation in the project area, coupled with limited exposure and structural constraints

(a)



(b)

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(c)

10 44 9500 63 900	10 44 9500 63 800	10 44 9500 63 700	10 44 9500 63 600	10 44 9500 63 500
10 44 9000 63 900	10 44 9000 63 800	10 44 9000 63 700	10 44 9000 63 600	10 44 9000 63 500
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10 44 8000 63 900	10 44 8000 63 800	10 44 8000 63 700	10 44 8000 63 600	10 44 8000 63 500
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Figure 1. (a) NTS index map for Nova Scotia showing the location of NTS sheets 11E/04 and 11D/13. (b) Index map of 1:10 000 digital maps for NTS sheet 11E/04 showing the location of released Nova Scotia Department of Natural Resources, Open File Maps (NSDNR, OFMs 97-001 to 97-006). (c) Index map of 1:10 000 digital maps for NTS sheet 11D/13 showing the location of the area addressed in this report.

makes evaluation of stratigraphy and the placement of map boundaries tenuous within this unit.

Halifax Formation

The Halifax Formation occurs in the western part of the mapped area (Figs. 2, 3) and is restricted to the Kinsac Synclinorium (Fig. 2). Two distinct map units, the Cunard and Glen Brook members, are recognized within the area and correlate with similar units to the north of the area (Horne *et al.*, 1997).

Cunard Member

The Cunard member, in the mapped area, consists of black, sulphide-rich slate and minor thin metasiltstone beds. This is in contrast to the Cunard member elsewhere in the Central Meguma Mapping Project area (Horne, 1995; Horne *et al.*,1997; Ryan *et al.*, 1996), where metasiltstone beds are abundant. Coarse sulphide, primarily pyrite, occurs as lenses along bedding planes, whereas elsewhere it occurs as coarse disseminated cubes (eg. Rawdon Synclinorium; Fig. 2). Fine-grained pyrrhotite commonly occurs along cleavage planes.

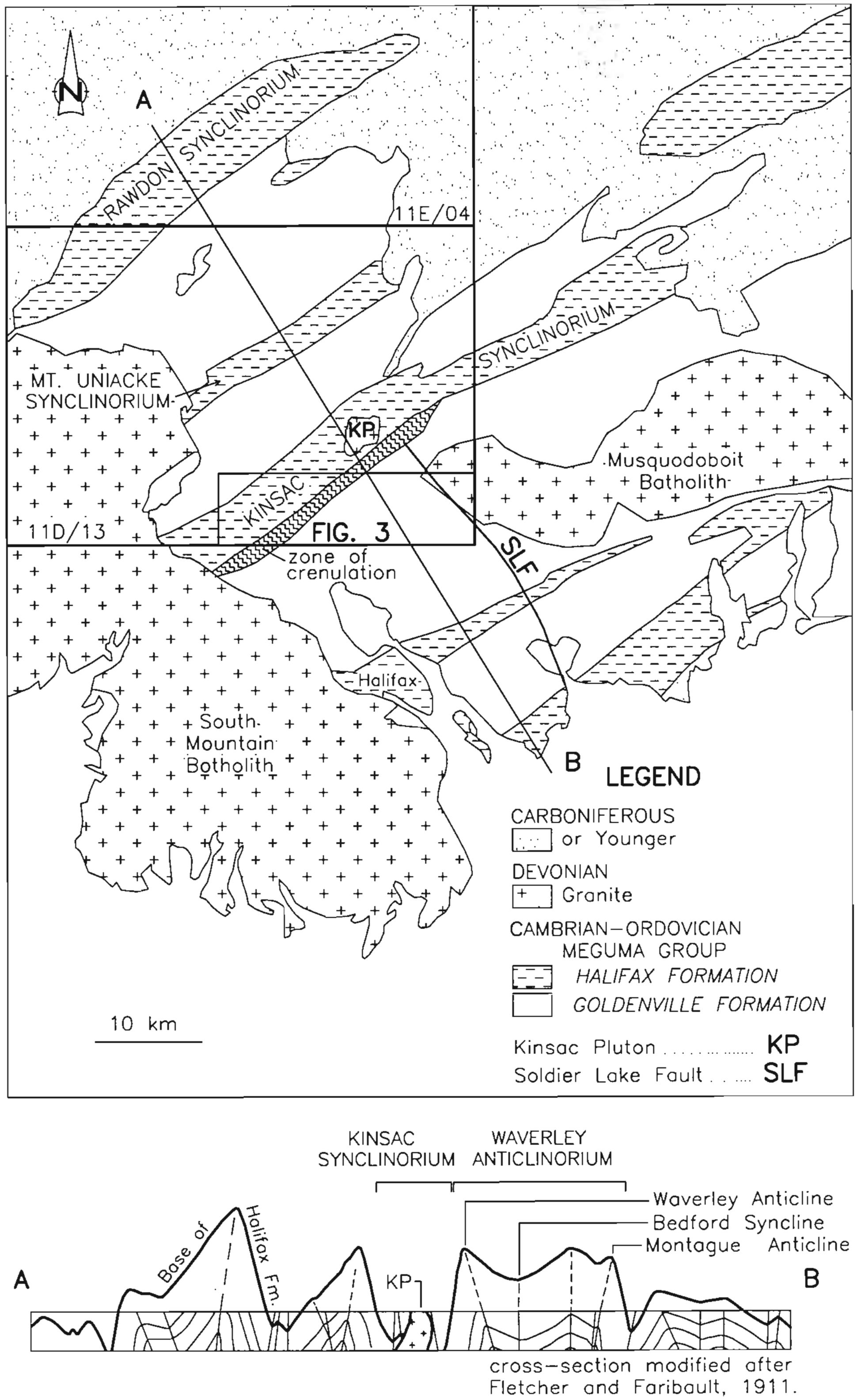

Figure 2. Simplified geological map and cross-section of the Central Meguma area showing the NTS map boundaries and the location of the area addressed in this report.

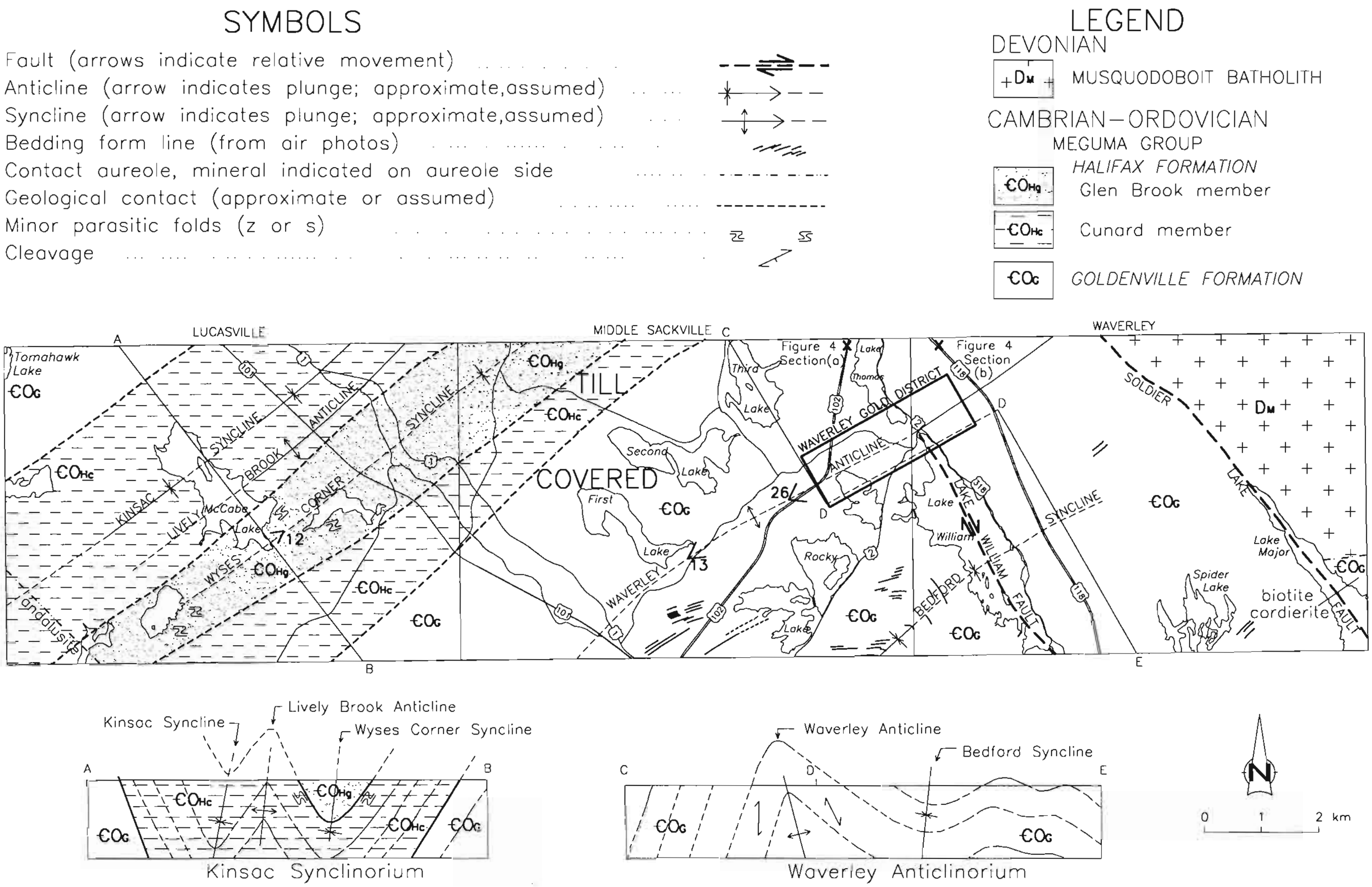

Figure 3. Simplified geological map and cross-sections of the study area (part of 11D/13). Map sheet names are indicated at the top of each of the three 1:10 000 maps. See Figure 4a, b for detailed stratigraphic sections located on Highway 102 and Route 118.

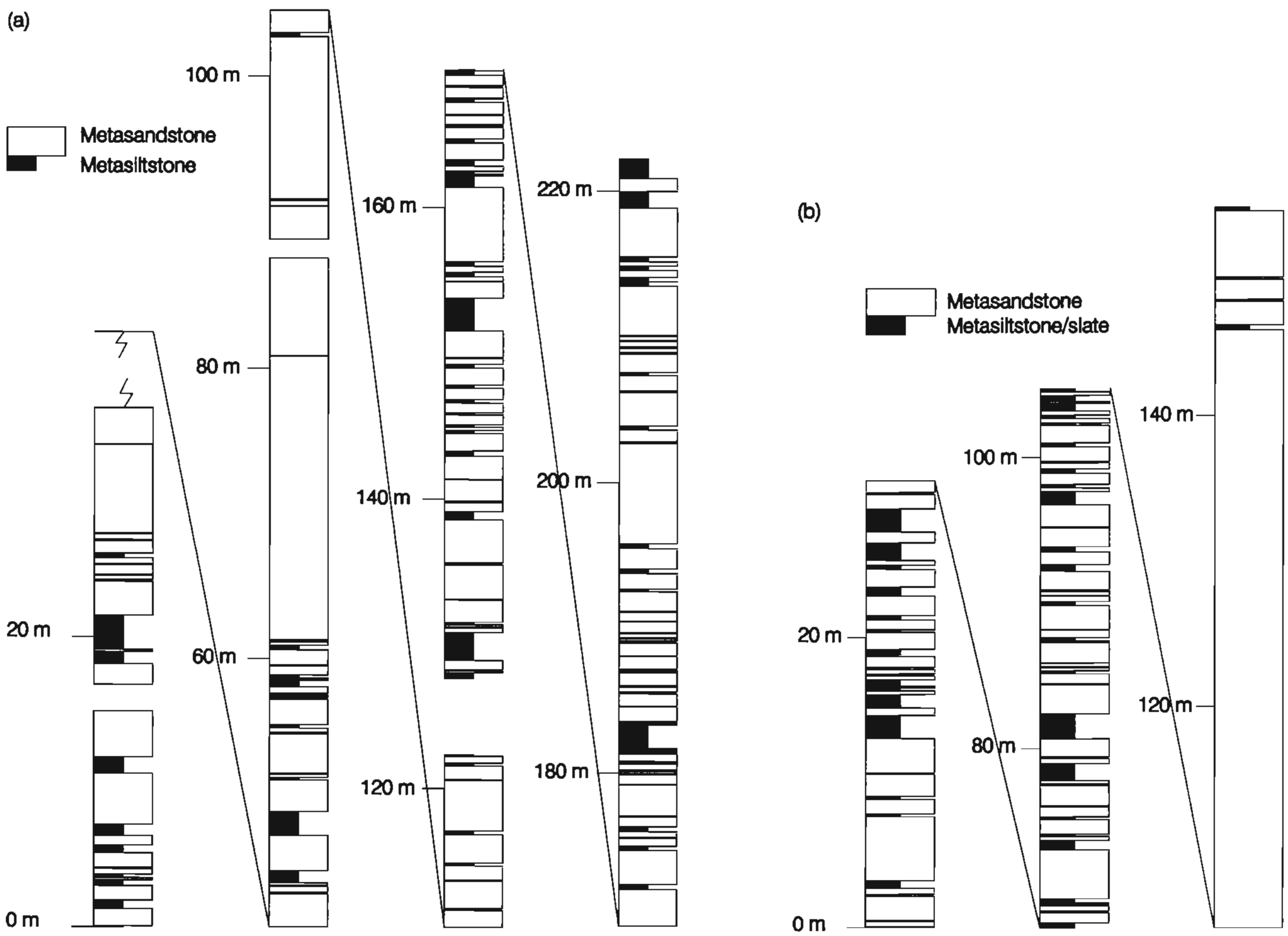

Figure 4. Detailed stratigraphic sections of the Goldenville Formation in the northern part of the mapped area from (a), along Highway 102, and (b), along Route 118. Location of sections indicated on Figure 3.

Glen Brook Member

The Glen Brook member conformably overlies the Cunard member and is restricted to the Wyses Corner Syncline (Fig. 3, Section A-B). This member consists predominantly of grey slate with thin (1-5 cm), crosslaminated metasiltstone beds (Fig. 5a) and local thin (10-30 cm) metasandstone beds. The Glen Brook member within the Kinsac Synclinorium differs lithologically from the equivalent member in the Rawdon Synclinorium (Fig. 2), where it is characterized by thinly banded grey-green metasiltstone and rare metasandstone beds (Horne, 1995; Horne *et al.*, 1997). The Glen Brook member in the Kinsac Synclinorium compares lithologically with the Feltzen member in the Mahone Bay area (personal observations), which is located at a similar stratigraphic level, supporting a general correlation with that member (Horne, 1995). The name Glen Brook is used here for continuity within the Central Meguma Mapping Project area. As discussed by Horne *et al.* (1997), the distribution of the Glen Brook member in the Kinsac Synclinorium corresponds well with a low aeromagnetic response within the Halifax Formation (King, 1997).

Structure

Regional, northeastward-trending folds are the dominant structure within the Central Meguma area (Fig. 2). In addition, systematic sets of joints and veins, a crenulation cleavage and several regional-scale faults have been recognized (eg. Horne *et al.*, 1997). Similar structures have been recognized within the mapped area and are discussed below.

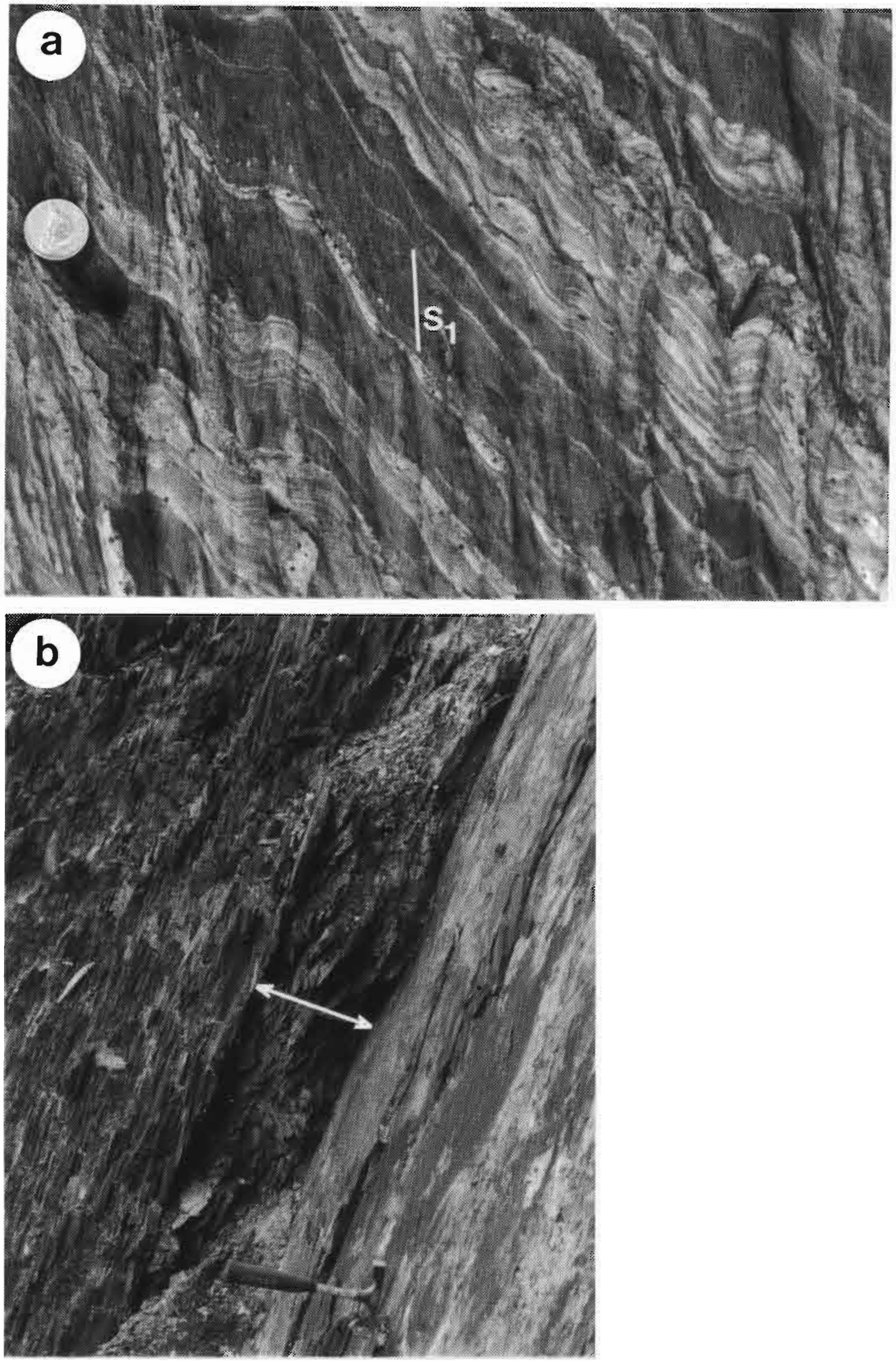

Figure 5. (a) Photograph of the Glen Brook member within the mapped area, characterized by grey slate with thin, laminated and cross-laminated metasiltstone (light coloured) beds. View represents a profile of the northern limb of the Wyses Corner Syncline looking northeast. Small-scale parasitic folds and bedding-cleavage relations indicate fold vergence to the northwest (left); S_1 = cleavage. (b) Photograph of a bedding-parallel fault zone, indicated by arrows, within the Cunard member on the southern limb of the Wyses Corner Syncline. View looking to the northeast. Faulting deforms cleavage, striations are downdip and a crenulation cleavage is developed in the footwall.

Folds

A cross-section through the Central Meguma area (Fig. 2) indicates folding is characterized by kilometre-scale, complex, box-style folds defining major anticlinoria and synclinoria consisting of several major and minor folds. The box fold geometry results in axial surfaces which show no systematic vergence. At the current level of exposure, anticlinoria are exposed mainly within the Goldenville Formation and characterized by broad, box-style folds, commonly with minor folding within the 'flat top' median segment, whereas synclinoria are exposed mainly within the Halifax Formation and characterized by narrow synclines and associated minor folds. In Horne *et al.* (1997) the major synclinoria, within the Central Meguma area (Fig. 2) are named.

Cross-sections of the mapped area (Fig. 3) indicate folds typical of the Meguma Group which include the Kinsac Synclinorium and the northern part of a broad anticlinorium defined by the Waverley and Montague anticlines, herein informally referred to as the Waverley Anticlinorium (Fig. 2). Sedimentary structures, bedding-cleavage relationships and minor fold symmetry (eg. Fig. 5a) indicate all folds within the area are upward facing. Bedding, cleavage and bedding-cleavage intersection data (Fig. 6a-c) indicate consistent northeastward-trending folds with slightly plunging hinges.

The Kinsac Synclinorium is defined by a belt of Halifax Formation and includes the Wyses Corner Syncline, Lively Brook Anticline and Kinsac Syncline (Fig. 3, section A-B). These folds were previously recognized by Faribault (1909), although our mapping resulted in local modification in the placement of the trace of fold hinges. The trace of the hinge of the Wyses Corner Syncline is constrained by the distribution of the previously undocumented Glen Brook member. These folds extend along strike to the northeast (Horne *et al.*, 1997).

The Waverley Anticlinorium within the area is dominated by the Waverley Anticline and minor folds to the south, including the Bedford Syncline (Fig. 3, Section C-D-E). The Waverley Anticline represents a chevron-style fold inclined to the south with the steep northern limb representing the northern limb of the anticlinorium (Figs. 2, 3). Our mapping results indicate a considerably different cross-section for the area south of the Waverley Anticline (Spider Lake area, Fig. 3, Section D-E) than previous mapping by Faribault (1909). Bedding attitudes in this area indicate shallow and variable dips south of the Bedford Syncline. The cross-section we have constructed would eliminate the need for the large dip-slip offset indicated on a steep fault interpreted by Faribault (1909) south of the mapped area.

Cleavage data for the area (Fig. 6b) define a regional trend parallel to fold traces and demonstrate a clear relationship to the fold geometry. For example, selected cleavage data for each limb of the Waverley Anticline (Fig. 6d) indicate similar bedding-cleavage angles for each limb, regardless of dip, and therefore an axial planar relationship to the fold (see Section C-E, Fig. 3).

Crenulation

A crenulation cleavage is locally developed within the Cunard member along the southern limb of theWyses Corner Syncline. This crenulation cleavage was also noted within the Cunard member along the southern limb of the Wyses Corner Syncline in the area northeast of the mapped area (Horne *et al.*, 1997), suggesting it represents a zone of deformation which is localized along the southern part of the Kinsac Synclinorium (Fig. 2). The crenulation is localized to narrow, bedding-parallel zones which are typically bounded by striated movement surfaces and interpreted to represent narrow shear zones (Horne *et al.*, 1997). Some movement horizons associated with the crenulation cleavage form well-developed, bedding-parallel fault zones (eg. Fig. 5b). Shear sense indicated by the crenulation and faulting is consistent with flexural-slip folding and these structures may reflect a late, regional deformation involving fold tightening.

Veins

Quartz veins are common throughout the mapped area (Fig. 7a). The three principal vein types recognized are bedding-parallel, en echelon and discordant (ac) veins (Fig. 7d). En echelon veins are strike-parallel, shallow dipping veins which are typically confined to individual beds (Fig. 7d) and reflect extensional veins related to reverse, bedding-parallel shear (flexural-shear) (Henderson *et al.*, 1986). Poles to bedding-parallel and en echelon veins plotted on a stereonet conform to data for poles to bedding (compare Fig. 7b and Fig. 6a). Discordant veins are the most common vein type and generally trend northwest-southeast (Fig. 7b), subparallel to the ac (profile) plane of regional folds, and parallel to prominent joints within the area (Fig. 7c). Similar observations were made in the area to the north of the mapped area (Horne *et al.*, 1997).

Figure 7a indicates a high concentration of veins along the hinge of the Waverley Anticline, suggesting

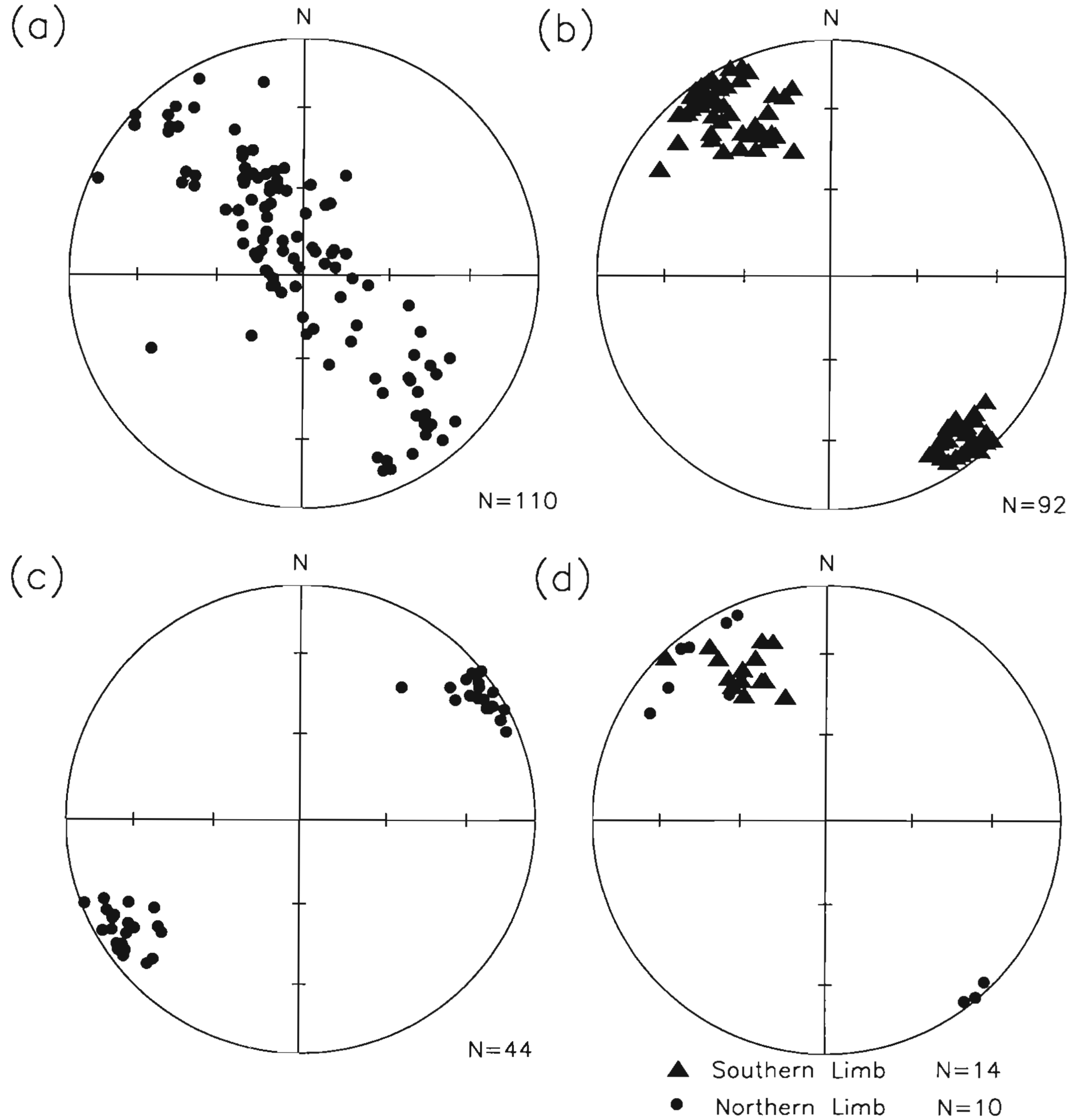

Figure 6. Stereonet data for the mapped area (part of 11D/13) for, (a) poles to bedding throughout the area, (b) poles to cleavage throughout the area, (c) bedding-cleavage intersections throughout the area, and (d) poles to cleavage for the northern and southern limbs of the Waverley Anticline.

structural control for vein emplacement. These veins do not include the numerous bedding-parallel veins documented within the Waverley Gold District and the majority of these veins are the discordant (ac) type. Localization of veins within the hinge area of the anticline may be explained by a flexural-slip (saddle reef) model, as suggested by Horne and Culshaw (1994, 1997) for the Ovens Gold District, where synchronous emplacement of bedding-parallel and discordant veins during flexural-slip folding is documented.

Abundant quartz veins were also locally noted within the Cunard member in several well exposed quarries. These veins were generally discordant and typically contained coarse pyrite, consistent with the their sulphide-rich hosts. Locally these veins were associated with crenulation structures and may represent veining associated with this late deformation.

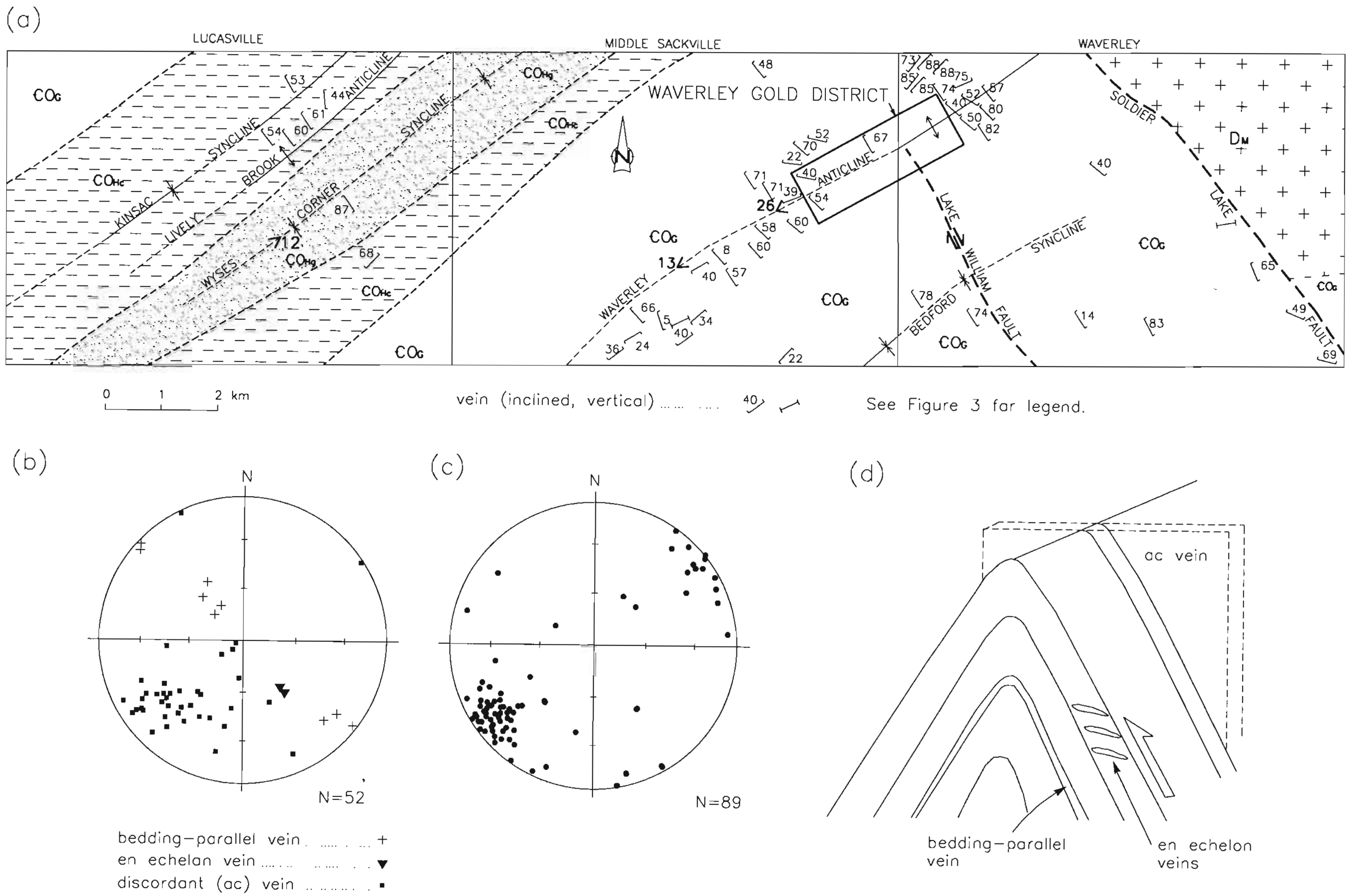

Figure 7. (a) Distribution of quartz veins in the mapped area (part of 11D/13), (b) stereonet of poles to quartz veins, (c) stereonet of poles to prominent joints within the area, and (d) sketch showing the relation of various vein types to the fold structure.

Faults

Soldier Lake Fault

The term Soldier Lake Fault (SLF) was applied to a regional-scale, northwest-southeast trending fault extending from Soldier Lake in the north to Cole Harbour in the south (Fig. 2; Horne *et al.*, 1997). Within the mapped area the SLF is exposed on Lake Major and extrapolated to the northwest (Fig. 3). The SLF in this area is characterized by a narrow zone of coarse fault breccia and a high density of slickensided fractures away from the fault, similar to deformation exposed on Soldier Lake (Horne *et al.,* 1997). Narrow, drusy quartz veins (locally amethyst) are common within fault-related fractures. Although the SLF defines the contact between the Meguma Group and the Musquodoboit Batholith (Fig. 3) no significant deformation is apparent within the granitic rocks. The contact aureole related to the Musquodoboit Batholith, which is defined by coarse biotite and cordierite porphyroblasts, is restricted to the eastern side of the SLF (Fig. 3), implying post-granite (Late Devonian) movement on this fault (Horne *et al.*, 1997).

Lake William Fault

The Lake William Fault is exposed on the southern end of Lake William (Fig. 3) and is characterized by cataclastic fault textures similar to those described for the Soldier Lake Fault. Although there is only limited exposure of the fault, it is interpreted as a northwestward-trending structure, underlying Lake William. This is consistent with a fault cutting the Waverley Gold District (Faribault, 1909).

Contact Metamorphism

Contact metamorphism associated with the Late Devonian South Mountain and Musquodoboit batholiths was recognized within the mapped area. Biotite and cordierite porphyroblasts occur within siltstone beds of the Goldenville Formation on the eastern side of Lake Major (Fig. 3). As noted above, contact metamorphism was not recognized on the western side of the Soldier Lake Fault, implying post-granite faulting. Coarse cordierite and andalusite (chiastolite) porphyroblasts occur within black slate of the Cunard member in the southwestern part of the area (Fig. 3) reflecting contact metamorphism related to the South Mountain Batholith (Fig. 2).

Summary

The geology of the mapped area is similar to adjacent areas of the Meguma Group. The Goldenville Formation has not been subdivided in the mapped area, or in the area to the north (Horne *et al.*, 1997). Ryan *et al.* (1996), however, proposed a tentative subdivision of Goldenville in the central part of 11D/13 and further evaluation is required to assess extension of their proposed units. The Cunard member of the Halifax Formation is recognized throughout the Central Meguma Mapping Project area and the Glen Brook member extends to the northeast of the mapped area and also occurs within the Rawdon Synclinorium. The Beaverbank member, which represents the lowest stratigraphic unit of the Halifax Formation within the Central Meguma Mapping Project area, was not recognized in the mapped area.

Structural elements within the area are recognized throughout the Central Meguma Mapping Project area. Cleavage, minor folds, joints and veins all show a geometric relationship to regional northeastward-trending folds. A locally developed crenulation cleavage occurs along the southern margin of the Kinsac Synclinorium and is interpreted as a late regional deformation involving tightening of regional folds. Regional-scale northwestward-trending faults cut the area and locally offset contact metamorphic aureoles related to Late Devonian plutons.

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