# LITHOPROBE seismic reflection imaging of Rocky Mountain structures east of Canal Flats, British Columbia[1]

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LITHROPROBE seismic reflection data, coupled with information from industry seismic data and surface geology, image the thin-skinned structures of the western Rocky Mountains from the Main Ranges to the Rocky Mountain Trench near Canal Flats, British Columbia. Reprocessing of the LITHOPROBE seismic reflection line was conducted to improve resolution of upper-crustal features. Careful application of "conventional" processing techniques significantly improved the coherence of reflections from the first 6 s. A spatial semblance filter was applied to further enhance coherent signal, and residual-statics corrections were applied by cross correlation of unstacked data with semblance-filtered pilot traces.

A near-basement reflection zone arising from Middle Cambrian strata is visible on an industry reflection profile at an approximate depth of 8 km beneath the Main Ranges. A similar reflection zone is imaged on the LITHOPROBE data at a depth of 11 km bsl but is interpreted as arising from Proterozoic strata. The autochthonous crystalline basement is interpreted as being below these layers and dipping about 2° to the west. Geometric evidence is visible for several major thrust ramps involving the basal décollement and for an intermediate-level décollement that loses displacement into folds within the Porcupine Creek Anticlinorium. Reflections related to the Gypsum fault, the Redwall thrust, and the Lussier River normal fault are also imaged.

Les données de sismique réflexion recueillies par le projet LITHOPROBE, combinées aux données sismiques disponibles venant de l'industrie et à la géologie de surface, fournissent une image des minces structures superficielles des Rocheuses occidentales des chaînes Principales jusqu'au sillon des Rocheuses, près de Canal Flats en Colombie-Britannique. Les données de la ligne de sismique réflexion du projet LITHOPROBE ont été traitées à nouveau afin d'améliorer la résolution des particularités structurales de la croûte supérieure. Une application méticuleuse des techniques « conventionnelles » de traitement de données a amélioré significativement la cohérence des réflexions pour les premières 6 s. Une filtration spatiale de l'image a été ajoutée pour mieux faire ressortir le signal cohérent, et la correction des parasites statiques a été accomplie en utilisant une corrélation croisée des données non-empilées avec des traçages pilotes filtrés de l'image.

Une zone de réflexion localisée près du socle, produite par les strates du Cambrien moyen, est visible sur un profil de sismique réflexion, fourni par l'industrie, à une profondeur approximative de 8 km sous les chaînes Principales. Une zone de sismique réflexion analogue est également révélée par les données du projet LITHOPROBE à une profondeur de 11 km bsl cependant elle est interprétée comme produite par des strates protérozoïques. Il semble que le socle cristallin authoctone soit sous-jacent aux strates protérozoïques et incliné à approximativement 2° vers l'ouest. Les particularités géométriques indiquent l'existence de plusieurs rampes majeures impliquant le décollement basal et aussi un décollement à un niveau intermédiaire où le déplacement cède la place à des plis intégrés à l'anticlinorium de Porcupine Creek. L'image de la faille Gypsum, du chevauchement Redwall et de la faille Lussier River a aussi été reconstituée à partir de leurs réflexions respectives.

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## Introduction

This study was undertaken to determine the seismic reflection structure of the Rocky Mountains from the Main Ranges to the Rocky Mountain Trench, based on information from LITHOPROBE and industry data. The LITHOPROBE data for this study are from line SCC-1B, the easternmost of six seismic-reflection profiles acquired in the fall of 1985 as part of the southern Canadian Cordillera transect. These profiles extend from the Rocky Mountain fold and thrust belt to Lower Arrow Lake within the Omineca crystalline belt (Fig. 1, inset); preliminary results for this transect were summarized by Cook *et al.* (1987, 1988). Line 1B is located east of the Rocky Mountain Trench near Canal Flats, British Columbia. Initial results for this line provided information on the depth to a reflection interpreted as layering near the top of North American basement. However, the data were not processed to enhance the imaging of upper crustal structures. For this study, reprocessing was conducted to enhance the coherence of reflections in the upper 6 s (about 17 km) and to relate features imaged by the seismic profile to surface geology. Interpretation of line 1B was linked with information from an industry reflection profile, line WR 40-24, located in the East White River valley (Fig. 1).

Initial results for line 1B show a zone of reflections, labelled NBR′ in Fig. 2, on the west side of the profile at a two-way reflection time of 4.5 s. The character of NBR′ strongly resembles Middle Cambrian near-basement reflections reported for nearby industry seismic reflection data (Bally *et al.* 1966). The depth to NBR′, about 12 km below seismic datum using an average velocity of 5300 m s$^{-1}$, is consistent with a gently west dipping basement surface beneath the Rocky Mountain fold and thrust belt at this latitude. However, the high level of random noise on these data, which is likely related to surface recording conditions, is evident in Fig. 2 and obscures possible reflections above NBR′ that would come from within the thick sedimentary section overlying the

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[1] LITHOPROBE Contribution 30.

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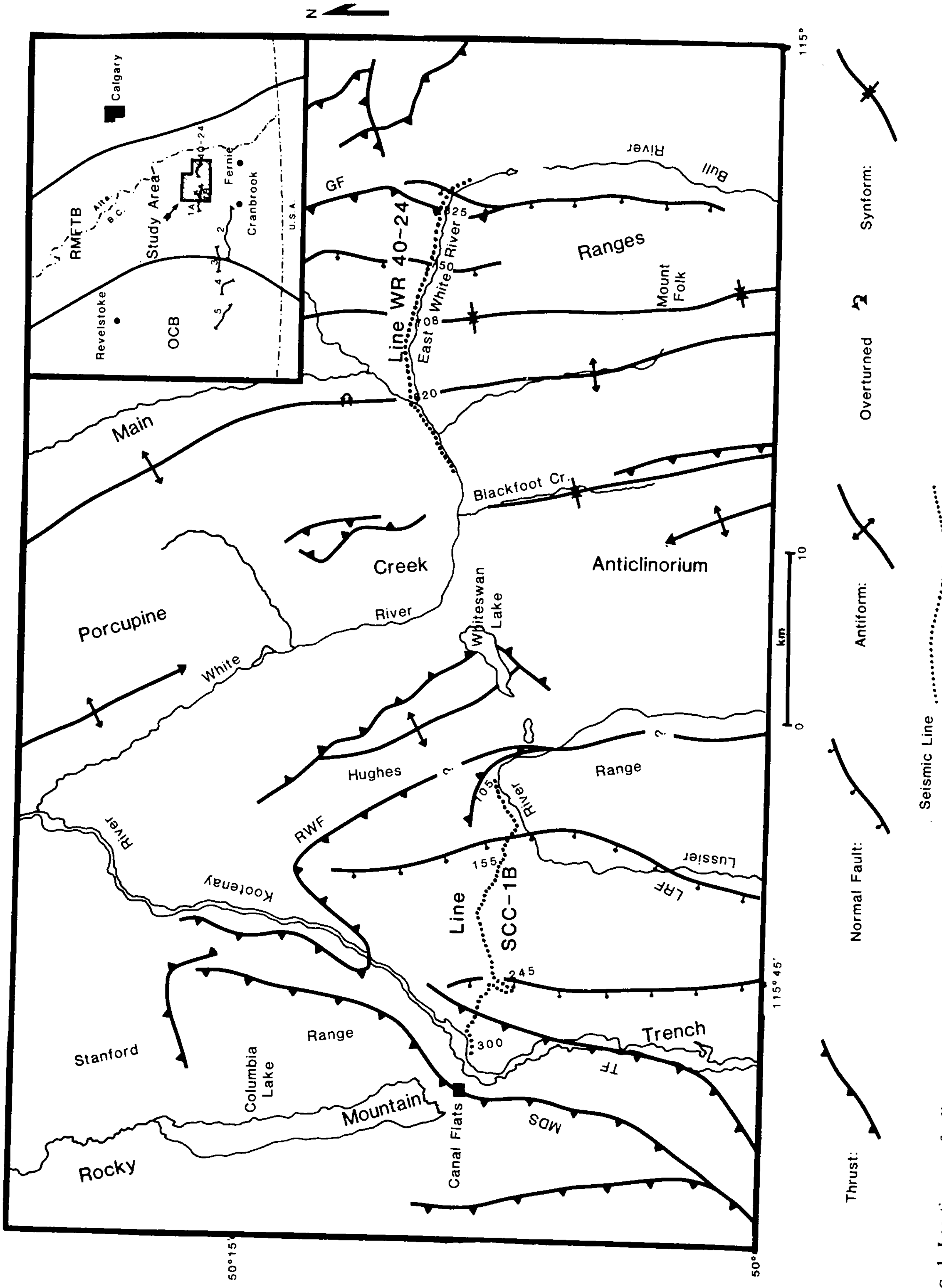

FIG. 1. Location map for lines SCC-1B and WR 40-24, showing major structural features (after Leech 1959, 1979; Mott *et al.* 1986). Inset also shows location of other lines from LITHOPROBE southern Canadian Cordillera transect (1A–5). RMFTB, Rocky Mountain fold and thrust belt; OCB, Omineca crystalline belt; MDS, Mount De Smet fault; TF, Torrent fault; LRF, Lussier River fault; RWF, Redwall fault; GF, Gypsum fault.

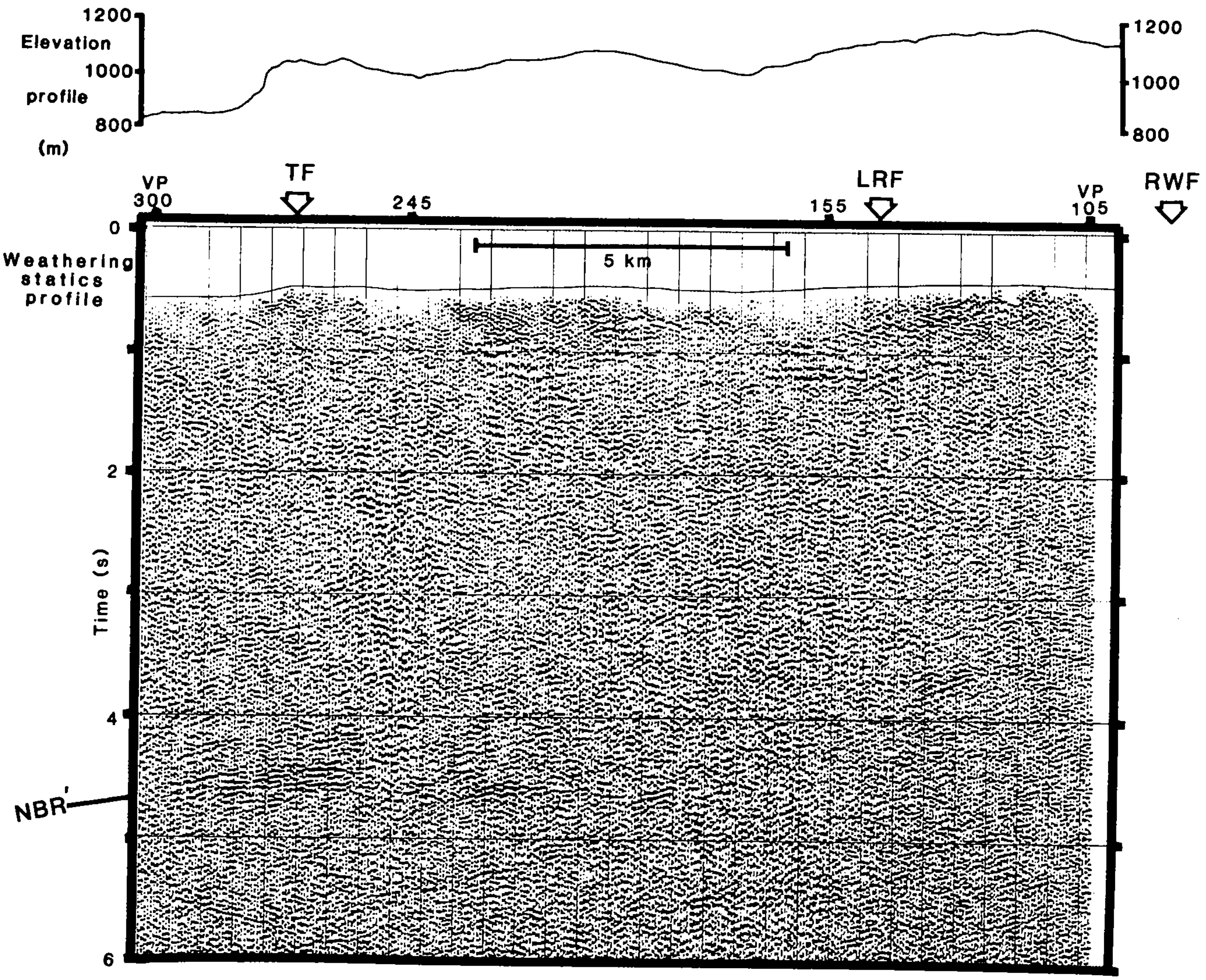

FIG. 2. Line 1B, first 6 s of initial unmigrated stacked section. NBR′, near-basement reflection; TF, Torrent fault; LRF, Lussier River fault; RWF, Redwall fault.

crystalline basement. Careful reprocessing of these data partly overcame the problem of obscured reflections and yielded significant new information pertaining to thrust and fold structures in the upper crust.

## Geologic setting

Lines 1B and WR are situated within the Western Ranges and Main Ranges subprovinces, respectively, and are oriented approximately across the strike of major structural features (Fig. 1). Although no cross lines are available, the crooked line geometry of the profiles provides evidence that the data are not severely contaminated by off-line reflection energy. The seismic profiles are separated by a 15 km gap across the central part of the Porcupine Creek Anticlinorium. Previous seismic-reflection studies (Bally *et al.* 1966) and geological studies (Price 1981) affirm the thin-skinned nature of deformation in the southern Canadian Rocky Mountain fold and thrust belt. Geophysical evidence for this structural style is particularly compelling east of the Main Ranges. The two profiles described here provide a strategic link between well-established thin-skinned structures to the east and less well understood structures imaged by LITHOPROBE, COCORP, and other data (Cook 1985, 1986; Potter *et al.* 1986; Cook *et al.* 1987, 1988) farther west in the Cordillera.

Stratigraphic units within the Main Ranges in the vicinity of line WR include the Upper Cambrian and Lower Ordovician McKay Group through to the sub-Devonian unconformity (Mott *et al.* 1986). They rest in the hanging wall of a thrust fault that is likely the northern extension of the Gypsum fault mapped 50 km to the south in the northern Fernie area by Benvenuto and Price (1979). However, the amount of displacement on this fault is unclear (J. A. Mott, personal communication, 1987). The surface trace of this fault intersects the seismic line 2 km from its east end near SP 825; 3 km farther west at SP 750 the line crosses a west-dipping normal fault (Mott *et al.* 1986). This part of the seismic line also parallels a significant tear fault (J. A. Mott, personal communication 1987). West of the normal fault, the profile enters the area of the Porcupine Creek Anticlinorium, characterized here mainly by large-scale, tight folds within the McKay Group (Leech 1979). The western termination of line WR occurs at the axial trace of a syncline near Blackfoot Creek (Fig. 1).

The Porcupine Creek Anticlinorium is an extensive fan structure formed within the Cambrian–Ordovician shale facies of the Cordilleran miogeocline that is marked by northeasterly verging cleavage and fold axes on its east side and southwesterly verging structures on its west side (Price and Gardner 1979). It abuts more competent coeval carbonate facies on the east and is overthrust by older, more competent rocks on the west (Price and Gardner 1979; Price 1986). A seismic-reflection profile was recorded about 150 km north of the present study area across the core of the anticlinorium near Golden, British Columbia (F. A. Cook, unpublished data, 1984). These data have been interpreted (Ferri 1984) as indicating that the near-basement reflector is nearly 12 km deep in that area and that the Cambrian Gog Formation is likely involved in tight folding. However, significant along-strike variations in structural style within the Porcupine Creek Anticlinorium (Price 1986) make seismic correlation from Golden to Canal Flats difficult.

The east end of line 1B is 15 km west of line WR. The line extends westward from the Hughes Range on the west flank of the Porcupine Creek Anticlinorium to the Rocky Mountain Trench (Fig. 1). The line begins on the east within the Lussier Canyon, near the surface trace of the Redwall thrust, a fault that is interpreted by Foo (1979), on the basis of mapping by Leech (1959), as a shallow-dipping thrust fault following a glide zone within gypsum of the Devonian Burnais Formation. East-dipping dolomites, shales, and argillaceous limestones in the Hughes Range lie in the hanging wall of the thrust and are Middle Cambrian to Silurian in age.

The line continues west across a broad, drift-covered valley, likely representing a graben controlled by a series of buried west-dipping normal faults mapped along strike as the Lussier River fault and associated splay faults (W. K. Foo, personal communication, 1987). Foo (1979) suggested that these faults are listric, merge at depth with the trace of the Redwal fault, and are analogous to the relationship of the Flathead and Fording Mountain faults with the Lewis thrust in southeast British Columbia and Montana (Dahlstrom 1970; McMechan and Price 1984). Early Tertiary extension on these normal faults represents the final phase of deformation in this area.

The line crosses another low range of mountains composed of a highly faulted east-dipping succession of Late Proterozoic and Cambrian strata on the east side of the Rocky Mountain Trench. At this position, the Torrent thrust crosses the trench at an oblique angle and intersects the seismic line near the east rim. The west end of the line is at the Kootenay River in the Rocky Mountain Trench, opposite the town of Canal Flats.

## Reprocessing results

The reprocessing operations applied to line 1B are listed in Table 1. Salient features of the pre-stack reprocessing sequence include careful trace edits and mutes, detailed velocity analyses, and surface-dependent limited-offset stacking. The results after application of these operations are shown in Fig. 3. The section displays more coherent energy than the initial stacked section (Fig. 2); reflection NBR′ can now be followed east to within 2 km of VP 155 with greater confidence than on the initial section (Fig. 2). Other zones of reflected energy that were not previously imaged clearly are indicated by letters A–C and are discussed below.

The next significant operation applied to the data was a spatial semblance filter. This algorithm was developed by Cheadle and Lawton (1986) and is similar to techniques discussed by Kong *et al.* (1985). It attenuates incoherent noise present on seismic data through the use of the statistical semblance parameter (Telford *et al.* 1976, p. 395). The results of application of this filter to line 1B are shown in Fig. 4. The degree to which reflected signal stands out above noise is now comparable to a line diagram; however, the interpretive bias inherent in the construction of a line drawing has been removed by this procedure. Tests have shown that reliable results can be obtained with this filter, even if the data have a large component of noise. However, caution was exercised when the semblance-filtered stacked section was interpreted, since filter artifacts in the form of discontinuous, "choppy" reflections were introduced. The semblance-filtered section is viewed as an additional tool for analysing the final stacked section.

TABLE 1. Acquisition and processing parameters—line SCC-1B

| | |
|---|---|
| Acquisition | |
| Number of vibrators | 4 |
| Receiver-group interval | 100 m |
| Source-group interval | 200 m |
| Number of channels | 120 |
| Nominal fold | 30 |
| Sweep length | 16 s |
| Sweep range | 8–40 Hz |
| Instrumentation | DFS-V |
| Geophone type | L-280 14 Hz |
| Processing | |
| Demultiplex | 14 s at 4 ms |
| Elevation statics | |
| Datum (flat) | 1050 m |
| Velocity | 4000 m s$^{-1}$ |
| Transmission-loss recovery | |
| CDP gather (crooked line) | |
| Trace edit and mutes | |
| Velocity analysis and normal moveout correction | |
| CDP stack (limited-offset ranges) | |
| Band-pass filter | |
| Trapezoidal | 8–12–32–48 Hz |
| AGC (RMS scaling) | |
| Window length | 2000 ms |
| Spatial semblance filter | |
| Semblance threshold | 0.35 |
| Array width | 17 traces |
| Window length | 50 ms |
| Slope limit | 167 ms km$^{-1}$ |
| Trim statics (correlation) | |
| Window | 1–5 s |
| Maximum static | 50 ms |
| Migration | |
| F–K | |

NOTES: DFS-V, Texas Instruments Inc. seismic recording instrumentation; CDP, common depth point; AGC, automatic gain control; RMS, root-mean-square.

A final reprocessing step was residual-statics correction by cross correlation, a technique that is common for processing seismic data (Taner *et al.* 1974). The pilot traces used for estimating the residual statics are usually determined from a brute stack that has had two-dimensional dip filtering or trace mixing applied. In our reprocessing, however, the pilot traces used for estimating residual statics were obtained from the semblance-filtered section (Fig. 4), as these traces represent a "best estimate" of the true reflectivity structure with minimum noise contamination. A portion of the profile from the central part of the line between 1.5 and 3.5 s is shown in

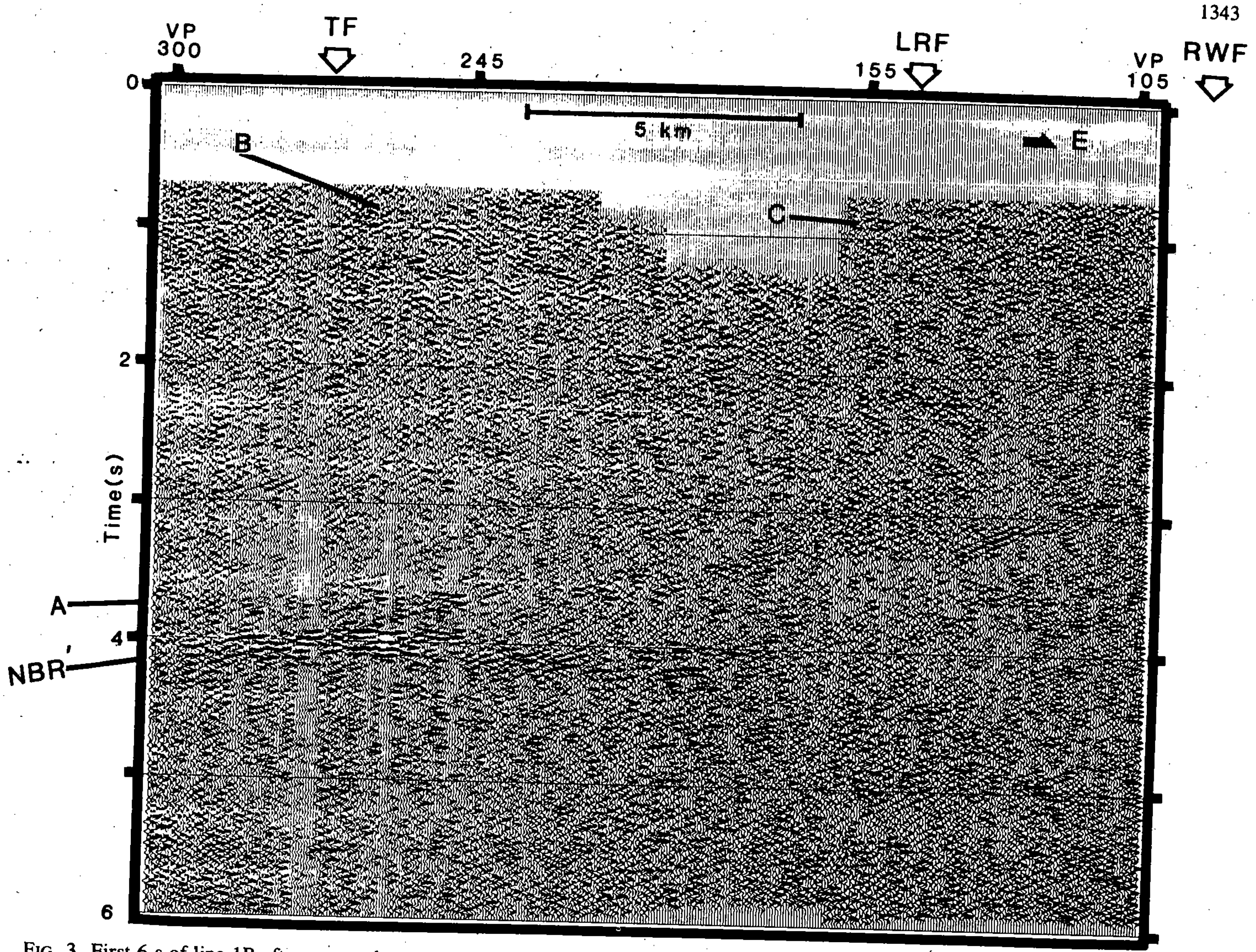

FIG. 3. First 6 s of line 1B after pre-stack reprocessing (unmigrated). Coherence of reflections has been significantly improved over initial results (Fig. 2). Reflections A, B, and C discussed in text. NBR', near-basement reflection; TF, Torrent fault; LRF, Lussier River fault; RWF, Redwall fault.

Fig. 5*a* after application of residual-statics correction. This part of the line falls within a broad, fault-controlled, alluvium-filled valley, where variation in weathered-layer thickness would be expected to produce difficult statics problems. Application of the new static corrections has enhanced the image of an antiformal structure (Fig. 5*b*), labelled D in Figs. 4 and 6.

## Data description

Line-drawing interpretations for the seismic profiles are shown in Fig. 6*a*. The line drawings have been displayed with the same horizontal and vertical scales, and appropriate datum-level shifts have been incorporated. Beneath the line drawings a schematic interpretation of the data (Fig. 6*b*) based on observed seismic-reflection geometries and surface geology is shown. The heavy-shaded zones represent reflection zones that are significant to the interpretation. The depth scale for Fig. 6*b* is dependent on the average p-wave velocity for the upper crust, which is not precisely known; there is no vertical or horizontal exaggeration for a velocity of 5300 m $s^{-1}$.

A zone of reflections interpreted as being the near-basement reflection (NBR) zone is clearly visible at and below 3 s on line WR and on the west side of line 1B at about 4 s, extending to a position 6 km from the east end of the profile (Fig. 6*a*). A weak zone of reflections (E) is also evident on line 1B at the east side of the profile at a reflection time of 3.6 s. Above this zone, a west-dipping event is visible from 3.1 to 3.3 s. NBR on line WR appears to project toward E, which is about 0.5 s above NBR' on line 1B.

A reflection zone marked A in Figs. 3, 4, and 6 is visible 0.4 s above NBR' on line 1B and appears to be truncated below VP 245. Between 2 and 3 s in the central part of line 1B, reprocessing has imaged the antiform (D) shown in Figs. 4 and 5. Underlying the antiform are a series of subhorizontal reflections, suggesting that a fault detachment separates these discordant reflection sequences. The reflection outlining the antiform appears to be offset near the crest of the structure. Migration of these data (not shown) did not cause this feature to collapse into a point, supporting the interpretation that the feature was not caused solely by a diffraction from a point source. The overall appearance of this feature is suggestive of a hanging-wall anticline containing a splay thrust fault that has propagated through the core of the fold.

The zone indicated as B in Figs. 3 and 4 marks a discon-

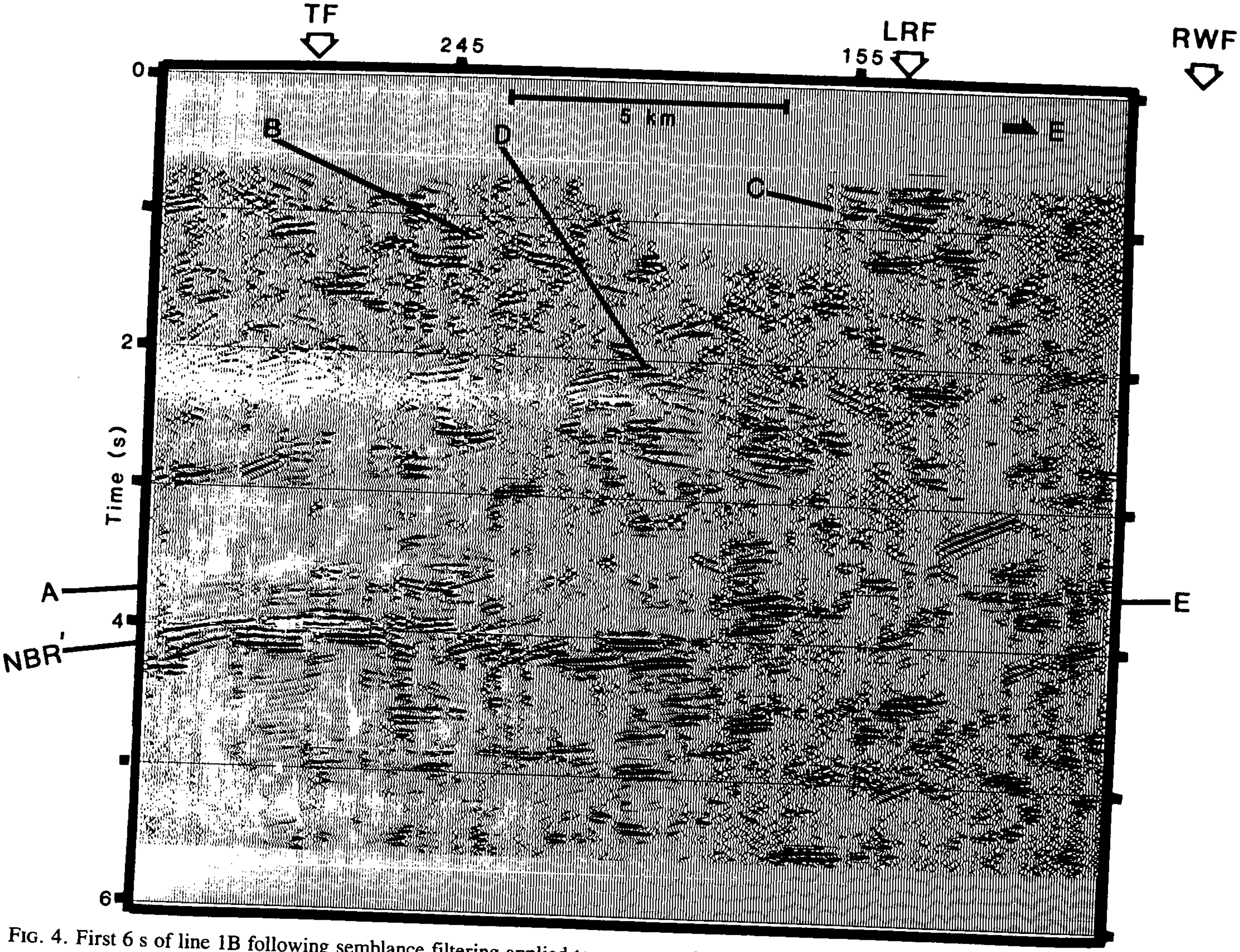

FIG. 4. First 6 s of line 1B following semblance filtering applied to reprocessed data (Fig. 3). This procedure enhances coherent signal and suppresses random noise. Reflections A–E discussed in text. NBR′, near-basement reflection; TF, Torrent fault; LRF, Lussier River fault; RWF, Redwall fault.

tinuity separating nearly horizontal reflections below from east-dipping reflections above it. This zone is truncated at a time of 1.8 s, where a cross-cutting, discontinuous series of west-dipping reflection segments are seen. Although these west-dipping reflections cannot be traced to the surface, it is possible that they project to a point near the Lussier River normal fault.

East of VP 155, a horizontal zone of reflections (C) (Figs. 3, 4, 6) is seen at 0.9 s. At the surface, strata dip to the east at 35–75°, suggesting that reflection C originates from beneath the Redwall thrust sheet. Foo (1979) interpreted the Redwall thrust as shallow dipping to the west, following a glide zone within the Burnais gypsum. Hence a possible source for this reflection is the Burnais gypsum. Foo's interpretation shows the Lussier River normal fault merging with the Redwall fault; however, it is also possible that the Lussier River fault cuts down through the Redwall fault (W. K. Foo, personal communication, 1987). The latter interpretation is preferred because it is more consistent with the geometry of reflections B and C. A reflection zone is visible 0.35 s below C that may correlate with B across the Lussier River fault; consideration of stratigraphic thicknesses beneath the basal Devonian unit suggests that these events may arise from within the McKay Group, which consists of alternating thick sequences of shale and carbonate, in a manner similar to Aitken's (1978) depositional Grand Cycles.

On the west side of line WR at a time of 2 s, a weak trend of reflections (F) appears to flatten at approximately the same level as the inferred detachment underlying antiform D. Between SP's 620 and 750 on profile WR several east-dipping zones of reflections are visible at 0.4–1.0 s two-way time. One possible interpretation for these reflections is that they arise from layered strata on the east-dipping flanks of folds observed at the surface.

Near the east end of line WR, a prominent trend of reflections (G) can be followed upward to the surface outcrop of the Gypsum fault. However, the presence of a good reflector here does not necessarily imply a large displacement on this fault. Beneath SP 708 at a time of 1.6 s (approximately 4.25 km) G appears to merge with another zone of reflections, suggesting that the Gypsum fault may be a splay thrust that soles into a deeper detachment, possibly the Bourgeau thrust that outcrops 15 km to the east. Below this, a horizontally layered reflection zone (H) with a thickness of several kilometres extends

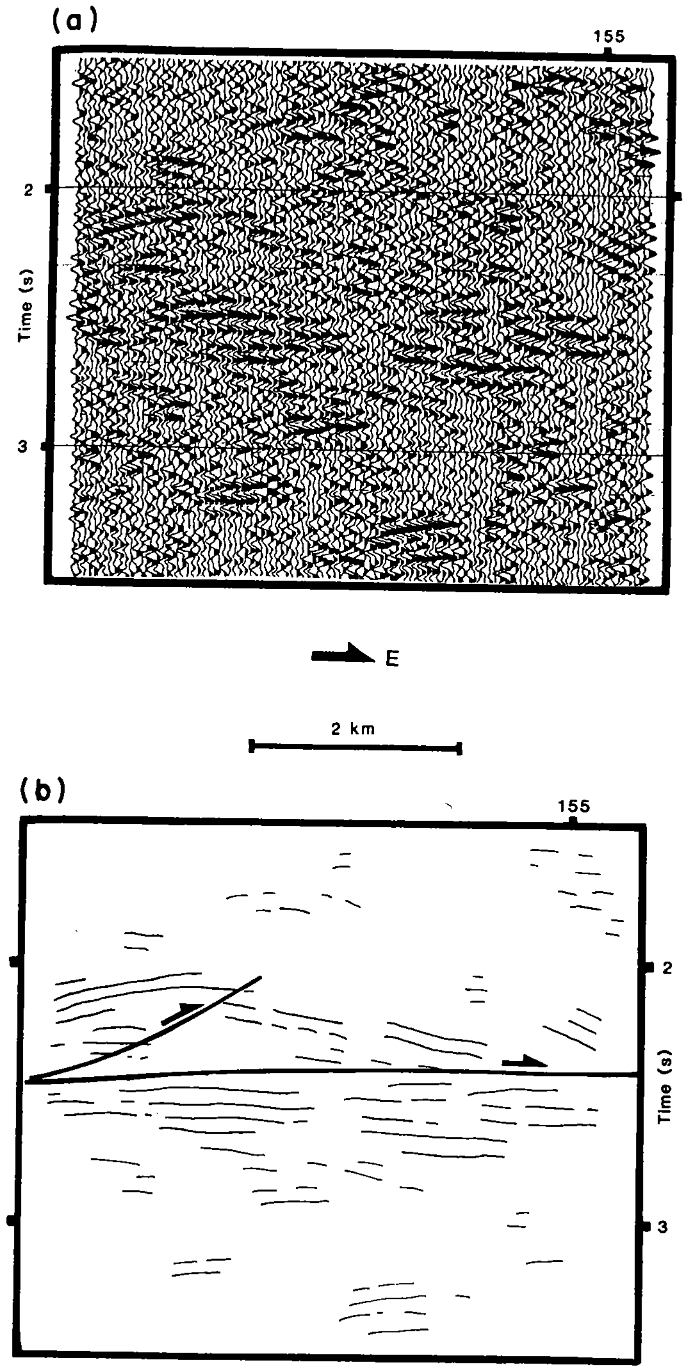

FIG. 5 (*a*) Enlargement of antiform structure (D in Fig. 4) from central part of line 1B. Data have been corrected for residual statics by cross correlation with semblance-filtered traces. This feature is interpreted as a hanging-wall anticline. (*b*) Line drawing interpretation for Fig. 5*a* showing interpreted thrust faults.

approximately 5 km from the east side of the profile. This zone of reflections is interpreted as originating from autochthonous lower Paleozoic rocks that are cut off by a thrust ramp, as indicated in Fig. 6*b*. The event that truncates H on this profile appears to be continuous with the uppermost events in zone H, perhaps carried above a footwall ramp in the Lewis sheet. The slight convergence–divergence of events in zone H supports the interpretation of a near-bedding-parallel thrust within it. Beneath H, the near-basement reflection probably arises from Middle Cambrian strata (Bally *et al.* 1966) and continues virtually uninterrupted to the west, dipping at a shallow angle.

## Discussion

Near-surface information used to construct the schematic model shown in Fig. 6*b* is simiplified from mapping by Leech (1959, 1979), Foo (1979), and Mott *et al.* (1986). Heavy lines indicate zones of reflections and distinguish the interpretation based on seismic reflection data from that based on surface geology. By analogy with other industry seismic data, reflection NBR′ on line WR is interpreted as layering near the top of North American basement. The relatively horizontal and continuous nature of the near basement reflection, particularly on line WR, is evidence that basement rocks are not involved in thrust structures. In the absence of evidence to the contrary, it is assumed that crystalline basement rocks are similarly passive beneath the Porcupine Creek Anticlinorium, where seismic control is not available.

The position of North American basement can be inferred to be below the base of layered reflections. The basement surface shown in Fig. 6*b* is consistent with the slope and depth to basement determined by Bally *et al.* (1966, Fig. 9). However, the depth to the Middle Cambrian NBR on line WR (1.42 s one-way time at $5300 \text{ m s}^{-1} = 7.5 \text{ km}$) and the basement depth of 9 km indicated in Fig. 6*b* imply that about 1.5 km of autochthonous Early Cambrian or older strata lie between the near-basement reflector and North American basement. Although well control east of the Foothills (Bally *et al.* 1966) shows a considerably thinner stratigraphic section at this level, the thickness of these units here is unknown. If basement is much closer to the base of reflections than shown in Fig. 6*b*, an alternataive interpretation would be an inflection in the basement surface within the gap separating lines WR and 1B.

Another important element of the interpretation is the subsurface geometry of the basal décollement into which other major thrusts sole. The relationship of major thrust faults to this décollement zone is most easily recognized on line WR, where it is reasonable to project reflection G soling into it immediately west of the profile. Two significant thrust ramps have been interpreted for this décollement. One is located near the east end of line 1B, and the other is 5 km from the east side of line WR (Fig. 6*b*). Similar ramp features have been inferred by Price (1981) and are shown on a regional cross section south of these profiles. It is also possible that a deeper detachment is located nearer to the top of North American basement. Such a configuration would allow a greater amount of shortening than is implied in Fig. 6*b*. However, as no evidence is visible on the available seismic data to support this interpretation, only the décollement with ramps is shown.

The good continuity of reflection NBR on line WR implies that autochthonous Middle Cambrian strata extend at least as far as the west end of the profile. Definitive correlation of this event across the seismic gap to line 1B is not possible; however, we interpret reflection E as correlating with NBR. This reflection is interpreted as being truncated in the footwall of a thrust ramp beneath the Hughes Ranges (east side of line 1B), implying that this is the western limit of autochthonous Middle Cambrian strata. The west-dipping reflection above E in Figs. 4 and 6 is considered a fault-plane reflection from this ramp. We also interpret that reflection NBR′ on line 1B, situated in the hanging wall of this décollement, originates from Proterozoic strata. Middle and upper Proterozoic rocks are carried to the surface by the Lewis thrust in areas to the south-

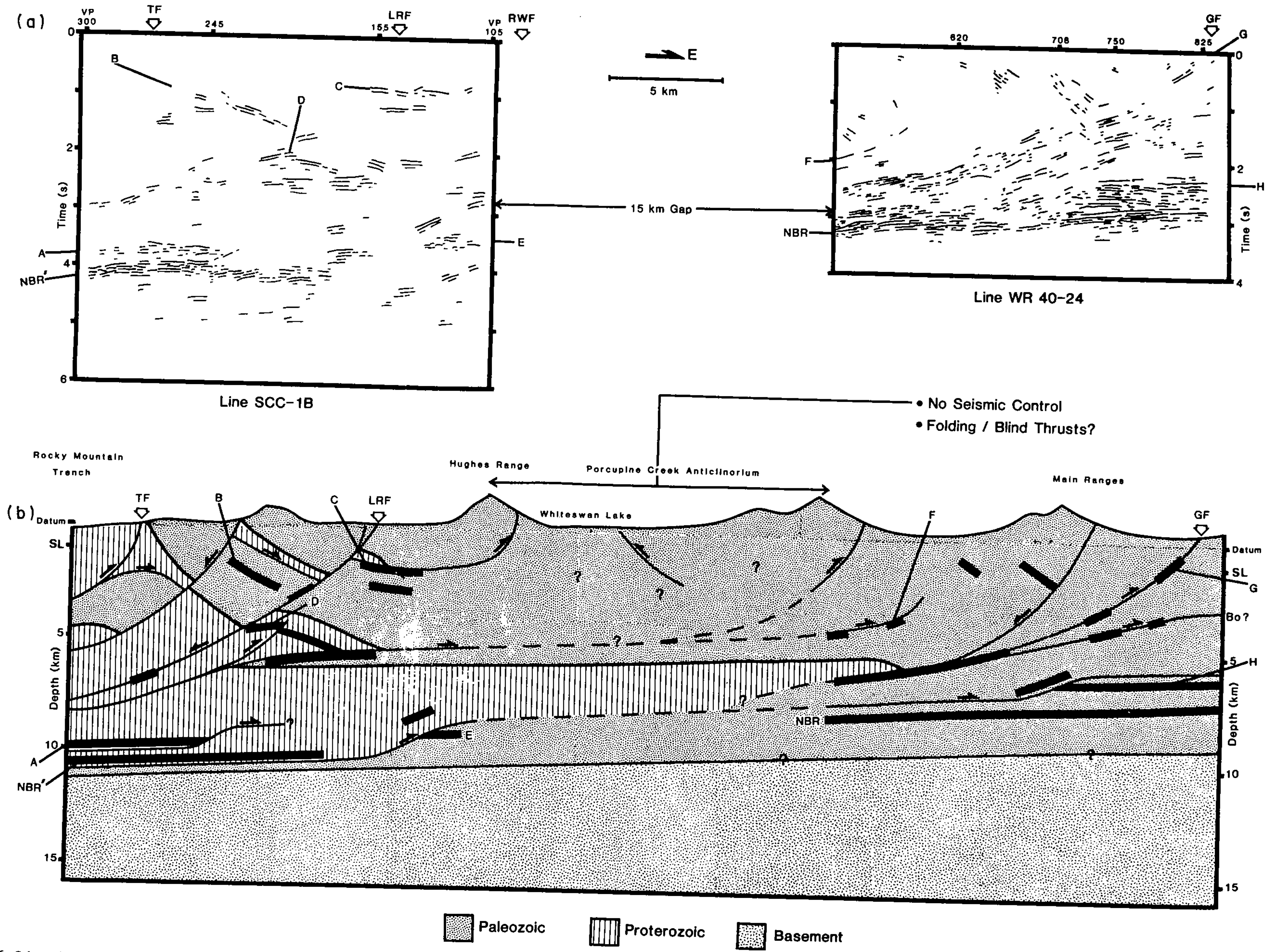

FIG. 6. Line drawings for (*a*) line SCC-1B and line WR 40-24 (unmigrated stacked sections) and (*b*) schematic interpretation for the seismic data. Dark lines on the schematic section represent reflection zones significant to the interpretation. Time to depth conversion calculated using 5.3 km $s^{-1}$ average velocity. Simplified near-surface geology after Foo (1979), Leech (1979), and Mott *et al.* (1986). Mountainous topography shown in (*b*) is projected 1–2 km onto the line of section. Interpretation within zone with no seismic control is intended only to illustrate linkage of features from one line to the next and is not intended to show actual structural interpretation. Reflections A–H discussed in text. NBR and NBR', near-basement reflections; TF, Torrent fault; LRF, Lussier River fault; RWF, Redwall fault; GF, Gypsum fault, Bo, Bourgeau fault; SL, sea level.

east and by the Castle Mountain thrust in areas to the north, respectively; it is therefore probable that Proterozoic rocks are carried by the basal décollement in the subsurface beneath line 1B. Moreover, proprietary industry seismic data to the south suggest that the Lewis thrust juxtaposes Middle Proterozoic reflecting layers with the Cambrian near-basement reflection in a similar fashion (P. L. Gordy, personal communication, 1986). An alternative interpretation to the footwall cutoff of NBR beneath the east side of line 1B is that autochthonous Middle Cambrian strata extend across the entire profile and that NBR′ correlates with NBR. However, the latter requires a much greater amount of shortening across the Rocky Mountain fold and thrust belt than is implied by Fig. 6*b*.

The presence of the apparent hanging-wall anticline (D) on line 1B and reflection F on line WR suggests that an intermediate level (5–8 km) blind thrust exists, as no significant thrusts are mapped between the Redwall fault and the Gypsum fault (Leech 1979). A regional cross section across the Porcupine Creek Anticlinorium to the north of this area (southwest–northeast; Price 1981) shows a similar blind thrust overlying the Cambrian Gog quartzite. In a manner consistent with this cross section and the seismic data, a thrust is indicated (location F in Fig. 6*b*) following a glide zone above a thin Paleozoic section. This interpretation requires that this thrust fault loses displacement upsection. The lost displacement would most likely be accommodated by splay thrusts into the cores of large folds within the Porcupine Creek Anticlinorium.

## Summary

Seismic reprocessing of line 1B from the LITHOPROBE southern Canadian Cordillera transect has resulted in improved imaging of structures within the 10 km thick deformed sedimentary section overlying the cratonic crystalline basement. The autochthonous basement dips approximately 2° to the west to a depth of 12 km beneath the Rocky Mountain trench near Canal Flats, British Columbia. The basal décollement of the Rocky Mountain fold and thrust belt is located above the basement and is interpreted as carrying Proterozoic strata in the subsurface over a thin wedge of lower Paleozoic rocks. Several thrust ramps are visible along the basal décollement that progressively cut off autochthonous Paleozoic units in the footwall. The western limit of autochthonous Middle Cambrian strata lies at least as far west as the west end of line WR and is interpreted as lying beneath the Hughes Range, 15 km east of the Rocky Mountain Trench. The Gypsum fault can be traced on the seismic data to its surface outcrop in the Main Ranges and can be projected to sole into the basal décollement.

Evidence is also provided for an intermediate-level décollement zone that dies out beneath the Porcupine Creek Anticlinorium. This evidence includes an apparent hanging-wall anticline imaged on line 1B above the detachment, a weak zone of reflections with listric geometry on the west side of line WR, and possible reflections from the Lussier River normal fault. Both the listric reflections (F) on line WR and reflections interpreted as arising from the Lussier River fault can be projected to sole into this intermediate-level detachment. Thrust displacement along this intermediate-level fault zone was most likely accommodated by folding within the mechanically weak argillaceous Cambrian–Ordovician rocks of the Porcupine Creek Anticlinorium. Finally, shallow horizontal reflections on the east side of line 1B, where surface strata dip steeply to the east, suggest that the Redwall fault is a shallow west-dipping thrust there and truncates the steeply dipping surface structures.

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